Essays on the Consequences of the European Eastern Integration Process on Border Regions in the EU-15

Von der Wirtschaftswissenschaftliche Fakultät der
Gottfried Wilhelm Leibniz Universität Hannover
zur Erlangung des akademischen Grades

Doktorin der Wirtschaftswissenschaften
– Doctor rerum politicarum –

genehmigte Dissertation
von

M.A., M.Sc. Pia-Luise Wassmann
geboren am 16.07.1986 in Stadthagen

2016

Erstgutachter: Prof. Dr. Stephan L. Thomsen

Zweitgutachter: Prof. Dr. Daniel Schiller

Tag der Disputation: 19. Dezember 2016

Acknowledgements

I would not have been able to write this dissertation without the help and support of many people. First of all, I wish to thank my supervisors Stephan Thomsen and Daniel Schiller for their guidance throughout the past years. Their support, critical questions and insightful suggestions have been invaluable for writing this dissertation and have made the project a truly interdisciplinary endeavor.

The individual essays have received manifold and invaluable feedback over the course of their creation, and I am indebted to the Lower Saxony Institute of Economic Research (NIW) as well as to the doctoral program of the Faculty of Economics at Leibniz University Hannover for granting the opportunity to participate in various national and international conferences and workshops, where I could present initial versions of the essays and receive valuable feedback. I would also like to thank the German Federal Bank (Deutsche Bundesbank) for providing financial support for the research on the first and second essays included in the dissertation. The third and fourth essays both emerged from a research project at the Lower Saxony Institute of Economic Research (NIW) commissioned by the Chamber of Commerce of Lower Bavaria (IHK Niederbayern) and the Chamber of Handicrafts of Lower Bavaria and Upper Palatinate (Handwerkskammer Niederbayern-Oberfalz), and I thank both chambers for granting me the opportunity to use the firm data collected in the course of the project for my own research.

Finishing this project was an unexpectedly time-consuming and emotional endeavor that would not have been possible without the everlasting love and support of my family. I also wish to thank my wounderful colleagues at the NIW and the Institute of Statistics for worthwhile discussions and advice as well as for work time with good company. And finally I wish to thank Alex, who has always helped and supported me, for all the happy moments we have spent together over the past years. I hope that one day, I will be able to make up for all the hours I spend at the desk instead of traveling the world together.

Summary

In the course of the European integration process, the nature of borders and border regions has undergone major changes. Border regions on the former external border of the European Union (EU-15) in particular have transformed from peripheral regions at the edge of the European Union (EU) to more central ones within an enlarged EU. The four essays in this dissertation focus on these border regions and assess various aspects of the European Eastern integration process in these regions. Conceptually, the four essays are based on two approaches to the study of borders and border regions in economic and regional geography: the *flow approach* and the *cross-border cooperation approach* that are introduced and discussed in the introduction of this dissertation (Chapter 1).

Following the *flow approach*, the first two essays (Chapter 2 and Chapter 3) evaluate the effects of two major institutional reforms, namely the EU Eastern enlargement in May 2004 and the accession of Poland and the Czech Republic to the Schengen Zone in December 2007, on the economic performance and public security in the Eastern border regions of the EU-15. Both essays apply quasi-experimental research designs to establish causal inference. Results in Chapter 2 show that on average, no statistically significant enlargement effect can be observed. The average effect, however, veils the fact that border regions are differently affected by the enlargement: the economic enlargement payoffs seem to be driven mainly by the regional economic performance and industrial structure prior to the enlargement as well as the regions' endowment with physical infrastructure. Regarding the effects of abolishing border controls at the German-Polish and German-Czech border on public security in German border regions, that are assessed in Chapter 3, results show that no significant effects can be observed for overall crime rates in German border regions as well as for most types of criminal offenses. The rate of burglaries in border regions, however, increased statistically significantly following the Schengen Acquis.

Following the *cross-border cooperation approach*, the third and fourth essays (Chapter 4 and Chapter 5) take a closer look at spatial cooperation patterns of firms in one particular border region, namely the German border region of Lower Bavaria. Based on original micro-data of regional firms, results show that Lower Bavarian firms cooperate primarily with local or regional partners, whereas cross-border cooperation is comparatively scarce. Results in Chapter 4 reveal that region-specific factors are relatively more influential on

the spatial cooperation patterns of Lower Bavarian firms than firm-specific ones. Regarding the relation between spatial cooperation patterns of Lower Bavarian firms and their innovation implications, results in Chapter 5 show that a spatially more diverse set of cooperation linkages increases firms' likelihood of innovating. Moreover, the spatial dimension of cooperation linkages correlates with the type of innovation introduced by Lower Bavarian firms.

The four essays' findings can contribute to the academic and public debate on the consequences of the European integration process in border regions in several ways: the first two essays provide initial empirical evidence on the heterogeneous and multifaceted effects of economic and political integration on the economic performance and public security in border regions in the incumbent member states. In doing so, they address questions that are of utmost relevance in the light of the current discussion of the future of the European Union and the Schengen Zone. The third and fourth essays provide initial small-scale empirical evidence on spatial cooperation patterns of firms as key economic actors within one particular German rural, low-technology border region. They can provide empirical evidence for policy-makers and regional stakeholders when designing regional cooperation strategies.

Zusammenfassung

Im Zuge der europäischen Integration hat sich das Verständnis von Grenzen und Grenzregionen verändert. Das wird vor allem in den Grenzregionen an der früheren östlichen EU-Außengrenze deutlich, die sich von peripheren Regionen am Rand der Europäischen Union (EU) zu binneneuropäischen Grenzregionen gewandelt haben. Die vier Aufsätze in dieser Dissertation untersuchen verschiedene Aspekte der europäischen Integration in diesen Regionen. Konzeptionell basieren die Aufsätze auf zwei Untersuchungsansätzen zur Studie von Grenzen und Grenzregionen in der Wirtschafts- und Regionalgeographie: Dem *Flow-Approach* und dem *Cross-Border Cooperation Approach*. Beide Ansätze werden im einleitenden Kapitel der Dissertation (Kapitel 1) vorgesellt.

Die beiden ersten Aufsätze der Dissertation (Kapitel 2 und 3) basieren auf dem sogenannten *Flow Approach* und untersuchen die Effekte zweier institutioneller Reformen – der EU-Osterweiterung 2004 sowie des Beitritts Polens und der Tschechischen Republik zur Schengenzone 2007 – auf die wirtschaftliche Leistungsfähigkeit und Kriminalität in Grenzregionen der alten EU-15 Mitgliedsstaaten. In beide Aufsätze werden quasi-experimentelle Forschungsdesigns genutzt, um die kausalen Effekte der institutionellen Reformen auf regionaler Ebene zu identifizieren. Die Ergebnisse in Kapitel 2 zeigen, dass die EU-Osterweiterung im Durchschnitt keinen signifikanten Effekt auf das Bruttoinlandsprodukt der deutschen, österreichischen und italienischen Grenzregionen hatte. Allerdings lassen sich für einzelne Grenzregionen statistisch signifikante Effekte nachweisen. Vor allem wirtschaftlich erfolgreiche Regionen mit einem starken Industriesektor und einer guten Verkehrsinfrastruktur konnten von der EU-Osterweiterung profitieren. Die Ergebnisse in Kapitel 3 zeigen, dass der Beitritt Polens und der Tschechischen Republik zur Schengenzone und die damit verbundene Grenzöffnung keinen Effekt auf die allgemeine Kriminalitätsrate sowie auf die Kriminalitätsraten der meisten Delikttypen hatten. Für Wohnungseinbrüche ist jedoch ein statistisch signifikanter positiver Effekt festzustellen, d.h. die Rate der Wohnungseinrüche in Grenzregionen stieg im Vergleich zur Rate in den Kontrollregionen nach dem Beitritt Polens und der Tschechischen Republik zur Schengenzone an.

Die beiden Aufsätze in Kapitel 4 und 5 folgen dem sogenannten *Cross-Border Cooperation Approach* und untersuchen räumliche Kooperationsbeziehungen von Firmen in der deutschen Grenzregion Niederbayern. Die Ergebnisse basieren auf Primärdaten nieder-

bayerischer Firmen, die im Zuge einer Unternehmensbefragung erhoben wurden. Die Daten zeigen, dass niederbayerische Firmen vor allem mit lokalen und regionalen Partnern kooperieren, wohingegen Kooperationen mit Partnern aus den Nachbarländern Österreich und der Tschechischen Republik vergleichsweise selten sind. Die Ergebnisse in Kapitel 4 verdeutlichen, dass die räumliche Ausgestaltung von Forschungs- und Entwicklungskooperationen vor allem mit der Wissensbasis und dem Marktpotenzial möglicher Kooperationsregionen assoziiert werden kann. Bezüglich des Zusammenhangs zwischen Kooperationsmustern und Innovationen zeigen die Ergebnisse in Kapitel 5, dass ein positiver Zusammenhang zwischen dem räumlichen Umfang der Kooperationsbeziehungen und den Innovationergebnissen eines Unternehmens besteht. Die räumliche Ausgestaltung und die Art der Kooperationsbeziehungen korreliert darüber hinaus mit den Innovationsarten.

Die Ergebnisse der vier Aufsätze tragen in unterschiedlicher Weise zur Literatur und zur öffentlichen Debatte bei. Die ersten zwei Aufsätze liefern empirische Evidenz hinsichtlich der Konsequenzen der EU-Osterweiterung und der Ausweitung des Schengenraums auf die Wirtschaftskraft und Kriminalität in Grenzregionen der alten EU-Mitgliedsstaaten. Diese Ergebnisse sind vor allem vor dem Hintergrund der aktuellen Debatte um die Zukunft der Europäischen Union und der Grenzfreiheit im Schengenraum relevant. Die letzten beiden Aufsätze liefern empirische Erkenntnisse über die Ausgestaltung räumlicher Kooperationsbeziehungen von Firmen in einer ländlichen Niedrigtechnologie-Grenzregion in Deutschland. Die Ergebnisse identifizieren einerseits Faktoren, die die Ausgestaltung der räumlichen Kooperationsmuster beeinflussen; andererseits zeigen sie Zusammenhänge zwischen Kooperationen und Innovationen von Unternehmen in der Region auf. Damit können die Ergebnisse wichtige Hinweise hinsichtlich der Ausgestaltung von Wirtschaftsförderprogrammen in Regionen mit einer ländliche Struktur sowie einer Dominanz von Niedrig- und Mitteltechnologie-Industrien liefern.

Keywords

English:

- Border Regions
- European Integration
- Firms' Spatial Cooperation Patterns

Deutsch:

- Grenzregionen
- Europäische Integration
- räumliche Kooperationsmuster von Firmen

Contents

List of Tables

List of Figures

Chapter 1

Introduction

In the course of the European integration process, the nature of state borders and border regions has undergone major changes (Newman, 2006; Wastl-Walter, 2011). While state borders have traditionally been perceived as physical barriers to the movement of people, capital, knowledge, goods and services, the economic and political integration of the European Union (EU) has contributed to a revised understanding of borders as bridges for cross-national economic activities in the economic and regional geography literature (Paasi, 2011). Along with the revised understanding of borders, the role of border regions has also changed. Border regions on the former EU external border in particular have transformed from peripheral regions at the edge of the European Union to more central ones within an enlarged EU. This entailed possible consequences for regional economic actors. Hence, the European Eastern integration process may have intensified cross-border commuting of regional employees, cross-border business activities of regional firms and the establishment of new cross-border cooperation linkages in these regions on either side of the border. At the same time, the large wealth differential between old and new member states may also have entailed an increase in price competition and illicit activities. Since it is in these border regions that the consequences of the European integration process may be most visible and tangible, these regions have become important interfaces for the integration process and are commonly perceived as unique laboratories for both challenges and possibilities of European integration in the economic and regional geography literature (see, for example, Anderson and O'Dowd, 1999; O'Dowd, 2002; Paasi, 2011).

The four essays in this dissertation focus on border regions on the former eastern external border of the old member states (EU-15) and assess various aspects of the European integration process in these regions. The first two essays, i.e. Chapter 2 and Chapter 3, evaluate the effects of two major institutional reforms, namely the EU Eastern enlargement in May 2004 and the accession of Poland and the Czech Republic to the Schengen Zone in December 2007, on the economic performance and public security in German as well as in Austrian and Italian border regions. Both essays focus on the regional-level effects of institutional reforms and apply quasi-experimental research designs to establish causal inference. In contrast, the last two essays, i.e. Chapter 4 and Chapter 5, take on a micro-perspective. They examine spatial cooperation patterns of firms, as key economic actors, in one particular border region, namely the German border region of Lower Bavaria. Both essays are based on original firm-level survey data of Lower Bavarian firms. While the third essay (Chapter 4) describes correlations between firm-specific and region-specific factors as well as firms' spatial cooperation patterns in Research and Development (R&D), the fourth essay (Chapter 5) assesses how spatial cooperation patterns of Lower Bavarian firms translate into innovation success.

The juxtaposition of both macro-level (regional-level) and micro-level (firm-level) research allows to assess the consequences of European Eastern integration process on border regions on the former EU external border in multiple ways. From a conceptual point of view, the essays respond to two conceptual approaches to border studies in economic and regional geography introduced by Van Houtum (2000). While the first two essays respond to the *flow approach*, assessing the measurable effect of the European Eastern integration process on socioeconomic indicators in border regions, the last two essays respond to the *cross-border cooperation approach*: both focus on the strategic behavior of firms as key economic actors in one distinct border region a decade after the EU Eastern enlargement. In applying both approaches, the essays in this dissertation account for the fact that a thorough understanding of the consequences of the European integration process in border regions in the old member states requires not only the quantitative assessment of integration effects at the regional level, but also the assessment of the strategic behavior of actors within these regions.

The remainder of this Chapter is structured as follows: the next section introduces common conceptual approaches to border studies in economic and regional geography and classifies the four essays according to these approaches. Section 1.2 summarizes the main research questions, empirical strategies and key results of the first two essays included in this dissertation, while Section 1.3 summarizes the research questions and empirical results of the third and fourth essays. Finally, Section 1.4 indicates how the findings can contribute to the academic and public debate on the consequences of the European integration process in border regions and provides an outlook for future research.

1.1 Conceptual Approaches to Border Studies

In the course of the European integration process, borders and their functions have gained more attention in the academic and public debate. Border studies have become an interdisciplinary subject developed in parallel work by economists, geographers, political scientists, lawyers, sociologists and other social scientists (Kolossov, 2005). Because of the interdisciplinary nature, no common conceptual framework for border studies exists. In the field of economic and regional geography, Van Houtum (2000) defines three conceptual approaches along which he classifies studies on borders and border regions. These are the *flow approach*, the *cross-border cooperation approach* and the *people approach*. While his framework has been revised and extended in recent conceptual works (see, for example, Sohn, 2014a and 2014b), the three approaches still constitute a comprehensive conceptual basis on which to classify border studies. In this dissertation, they allow for a categorization of the four essays according to their problem orientation, theoretical framework and methodological characteristics.

The *flow approach* is based on the classic European location theorists such as Giersch (1950) and Lösch (1944) (see Van Houtum, 2000; Sohn, 2014a) and also follows New Economic Geography (NEG) theories introduced by Krugman (1991). In this approach, borders are perceived as artificial barriers to economic activities, which would otherwise flow (Sohn, 2014a). Borders thus constitute obstacles to the free market, which prevent the optimal allocation of resources and the balance of spatial disequilibria in economic development (Van Houtum, 2000). Consequently, border regions are perceived as peripheral regions that are disadvantaged by their geographic location because of their limited

market area (Niebuhr and Stiller, 2002). The moment de-bordering occurs, border regions are, however, assumed to profit from their geographic proximity and gateway location to the adjacent regions (Sohn, 2014a). Studies that follow the *flow approach* focus primarily on measuring the quantitative effect of borders by the use of gravity models based on physical distance (see, for example, Brülhart *et al.*, 2004; Crozet and Koenig, 2004) or on identifying the measurable effects of abolishing borders (see, for example, Head and Mayer, 2000; Nitsch, 2000). In this approach, physical distance, transportation costs and accessibility are important concepts (Van Houtum, 2000).

The *cross-border cooperation approach*, on the other hand, stresses the need to understand the process of cooperation and networking of regional actors within border regions rather than estimating the effects of the presence or absence of borders on cross-border factor flows (Van Houtum, 2000). In contrast to the *flow approach*, border regions are no longer perceived as passive spaces that may benefit or be harmed by integration processes, but as active spaces, i.e. as distinct socio-territorial units endowed with strategic capacity of regional actors (Perkmann, 2003; Sohn, 2014a). The *cross-border cooperation approach* hence focuses on the strategic behavior of actors in border regions and their willingness to engage in cross-border cooperation. According to Van Houtum (2000), this approach is linked to a more general interest in integration and cooperation in economic and regional geography. Terms and concepts such as clusters, districts, networks, embeddedness, cooperation, transaction costs, trust and learning are consequently important buzzwords within the approach (Van Houtum, 2000). Studies that apply the *cross-border cooperation approach* focus not only on physical distance, but also on cultural or institutional distance and on the challenges and possibilities of cross-border economic activities (see, for example, Lundquist and Trippl, 2013 on cross-border innovation systems). The *cross-border cooperation approach* has also been taken up in multiple policy programs in the past two decades, aiming to stimulate the establishment and development of cross-border cooperation networks such as Interreg programs by the European Commission (EC) or regional attempts to create cross-border Euroregions (see, for example, Scott, 2000 for the German context).

The *people approach* differs from the first two approaches in that the analysis of borders and border regions is replaced by analyzing the mind-sets of individuals taking part in cross-border interaction (Van Houtum, 2000). In this approach, borders and border

regions are perceived as social constructs, following the social constructivist paradigm introduced by Berger and Luckmann (1966). Borders are assumed to evolve by the images and perceptions of people and are defined through the meaning people attach to them (Paasi, 1999 and 2001). The focus of the *people approach* is hence on the emotional reactions, actions and origins of individuals confronted with cross-border integration processes. Consequently, cognition, perceptions and identity are key words in studies that follow this approach (Van Houtum, 2000).

The four essays of this dissertation follow primarily the conceptual framework of the *flow approach* and the *cross-border cooperation approach*. The *people approach*, in contrast, is not part of the focus of this dissertation. The first two essays, i.e. Chapter 2 and Chapter 3, both respond primarily to the *flow approach*. Hence, they measure the impact of the European eastern integration process on the economic performance and public security in border regions. They presume that physical distance matters and border regions are especially affected by the European integration process due to their geographic location. In contrast, Chapter 4 and Chapter 5 primarily respond to the *cross-border cooperation approach*, because both essays focus on the behavior of economic actors in one particular border region and identify cooperation patterns of firms in this region. They account for the fact that cross-border integration does not derive from the mere opening of borders, but stems from the strategic behavior of actors and their willingness to cooperate.

1.2 The Impact of Institutional Changes on Border Regions

As outlined above, the first two essays of this dissertation, i.e. Chapter 2 and 3, evaluate the effects of two major institutional reforms in the course of the European Eastern integration process on border regions in the old member states. In doing so, both essays follow the initial assumption of the *flow approach*, namely that physical distance matters and that border regions are particularly affected by the European Eastern integration process. The European Eastern integration process started with the fall of the Berlin Wall and the collapse of the Soviet Union, when the European Union incrementally increased its relationships with its neighbors to the East (Epstein and Jacoby, 2014).

The stepwise integration process culminated in the EU Eastern enlargement in May 2004, enabling – with some transition regulations – free movement of goods, services, capital and labor between the EU-15 and the new Eastern member states, namely Poland, the Czech Republic, Estonia, Latvia, Lithuania, Slovakia, Slovenia and Hungary (Epstein and Jacoby, 2014). Compared to previous enlargement rounds, the EU Eastern enlargement differed in terms of size and in terms of economic and social discrepancies between old and new member states. Hence, the geographic expansion in 2004 was larger than in any of the previous rounds and the wealth differential between old and new member states was more distinct than was the case in any of the previous rounds (Baas and Brücker, 2010). Mainly because of the large wealth differential, the enlargement was accompanied by public concerns in the old member states about a depression of wages, increased unemployment and economic stagnation due to an increased competition from the East. Concerns were especially visible in border regions, fueled by the perception that their geographic location on the border to the new member states made these regions particularly vulnerable to price competition from the East (see Forster, 2007; Trettin, 2010 for Germany). In contrast to public concerns, theoretical contributions in the field of New Economic Geography (NEG) suggest that border regions in the old member states should actually profit from the EU Eastern enlargement, given their privileged access to the new markets (see, for example, Brülhart *et al.*, 2004; Brülhart, 2011). Despite these theoretical contributions, empirical research on the topic is comparatively scarce. Hence, it is still unclear as to whether border regions have been particularly affected by the integration process and whether potential effects are positive or negative. As Petrakos and Topaloglou (2008) put it, it is actually unclear whether border regions indeed turn from barriers to bridges in the integration process and inherently benefit from cross-border interaction, or whether they remain peripheral regions that are not profoundly affected by economic and political integration despite their geographic location.

Against this background, the first essay of the dissertation evaluates the effect of the EU Eastern enlargement on the regional Gross Domestic Product (GDP) per capita of border regions in the old member states. The empirical analysis includes German regions on the border to Poland and the Czech Republic, Austrian regions bordering the Czech Republic, Slovenia, Hungary and Slovakia, and an Italian region, which shares a border with Slovakia. To establish causal inference, in the essay (Chapter 2), the Synthetic

Control Method (SCM) is applied. This method has been introduced by Abadie and Gardeazabal (2003) and has been refined by Abadie *et al.* (2010 and 2015). Basically, it contrasts the economic performance of border regions after the EU Eastern enlargement in 2004 with synthetic control groups that approximate the counterfactual situation, i.e. the economic performance of border regions had the EU Eastern enlargement not taken place. Results show that on average, no statistically significant enlargement effect can be observed. However, for individual border regions, statistically significant enlargement effects are visible. These heterogeneous effects suggest that the border location is not sufficient to profit from changes in market access. When assessing potential factors that drive the results, it becomes evident that the regional economic performance and industrial structure prior to the enlargement as well as the regions' endowment with physical infrastructure are important indicators for integration success. These findings are in line with other empirical works, suggesting that economically successful regions may be better equipped to exploit the potentials of economic integration (Krätke and Borst, 2007; Petrakos and Topaloglou, 2008).

The EU Eastern enlargement is not the only institutional reform that may have affected border regions in the old member states. The accession of Poland and the Czech Republic as well as four other Eastern European countries to the Schengen Zone in December 2007 was another major institutional change that profoundly changed the role of borders between Germany and its Eastern neighbors. The implementation of the Schengen Acquis in Poland and the Czech Republic entailed the abolishment of passport and any other type of border controls at the German-Polish and German-Czech border and accelerated the speed with which people and goods move across borders. The removal of physical barriers was also accompanied by widespread concerns about public security (Killias, 1993; Schwell, 2009 and 2015). Media coverage suggested that concerns were again particularly strong in border regions, given their geographic proximity to Poland and the Czech Republic (Rother, 2007; Sohn, 2014a; Weber, 2007). The second essay of this dissertation assesses whether these fears were justified. Hence, it investigates whether the abolishment of border controls at the German-Polish and German-Czech border affected crime rates in German counties (Landkreise) bordering these two countries. In this essay, difference-in-difference estimations on matched samples, i.e. conditional difference-in-difference estimations (see Blundell and Costa-Dias, 2000; Smith and Todd, 2005), are

applied to evaluate the Schengen effect in a causal way. Results show that no significant Schengen effect on crime rates in German border regions can be identified for most types of criminal offenses as well as for overall crime rates in German border regions. However, for the rate of burglaries, a statistically significant increase in border regions can be observed. This suggests that for burglaries, public concerns proved to be true and public authorities would do well to counteract criminal activities in border regions and signal political awareness. In light of the current discussion on the future of the Schengen Zone and borderless Europe, the findings could not be more relevant, as they suggest that at least for border regions at the German-Polish and German-Czech border, there is only little empirical support for the widespread concerns about public security.

1.3 Spatial Cooperation Patterns of Firms in the German Border Region of Lower Bavaria

In contrast to the first two essays, the last two essays, i.e. Chapter 4 and Chapter 5, zoom in on one particular border region, namely the German border region of Lower Bavaria. Both essays investigate spatial cooperation patterns of regional firms as important economic actors. Since they focus on the strategic behavior of regional firms, both essays follow the *cross-border cooperation approach* introduced above. The region of Lower Bavaria constitutes an interesting case to study firms' spatial cooperation patterns, as the region's geographic location on the border to Austria and the Czech Republic provides regional firms with various spatial cooperation opportunities within the same geographic radius. Consequently, it allows to draw conclusions about the relative importance of cooperation on various spatial scales. The empirical analysis of both essays is based on original firm data of 732 Lower Bavarian firms of various sizes and sectors that were collected in the course of a research project at the Lower Saxony Institute of Economic Research (Niedersächische Institut für Wirtschaftsforschung, NIW) commissioned by the Chamber of Commerce of Lower Bavaria (Industrie- und Handelskammer Niederbayern, IHK Niederbayern) and the Chamber of Handicrafts of Lower Bavaria and Upper Palatinate (Handwerkskammer Niederbayern-Oberpfalz) between February and April 2013. Due to the collaboration with the local chambers, it was possible to

draw firm addresses from their firm databases and conduct a firm survey based on a specially designed questionnaire. This enabled a detailed inquiry about firms' spatial cooperation-linkages that exceed the information included in official firm surveys such as the Community Innovation Survey (Mannheimer Innovationspanel) or the Firm Panel of the Institute for Employment Research (Institut für Arbeitsmarkt- und Berufsforschung, IAB).

To be precise, the third essay (Chapter 4) describes spatial cooperation patterns of Lower Bavarian firms in Research and Development (R&D) and examines the relative influence of firm-specific characteristics, such as firm size and sector, and region-specific characteristics, such as geographic and institutional proximity, on firms' spatial cooperation patterns. Results reveal that Lower Bavarian firms predominantly cooperate with local or regional partners, whereas cross-border cooperation is comparatively scarce. This finding is in line with the literature on the embeddedness of knowledge in a particular regional context and the challenges associated with cross-border cooperation (see, for example, Asheim and Gertler, 2005; Trippl, 2010). Regarding the factors that may explain spatial cooperation patterns of firms, results suggest that region-specific factors are relatively more influential on firms' spatial cooperation patterns than firm-specific ones. The local knowledge base with which a region provides a firm, and the function that a region fulfills within the value chain of a firm thereby seem to be equally influential than common factors such as the geographic or institutional proximity of a region vis-à-vis Lower Bavaria.

The fourth essay (Chapter 5) expands the empirical analysis of the third essay by considering both the spatial and functional dimension of cooperation. It, hence, differentiates between Research and Development (R&D) cooperation and application-oriented cooperation, such as cooperation in the areas of production, procurement and/ or sales, and investigates the interplay between these two dimensions of cooperation and firms' innovation outcomes. On the output side, the essay differentiates between technology and non-technology innovation to account for the fact that firms in peripheral and low-technology regions in particular innovate via low-threshold innovation (Hirsch-Kreinsen, 2008; Hirsch-Kreinsen *et al.*, 2005; Robertson and Patel, 2007). Empirical results show that firms with a spatially more diverse scope of cooperation linkages are more likely to innovate. This suggests that both intra-regional and inter-regional cooperation linkages

are important, a finding that is in line with common concepts of spatial knowledge acquisition (see, for example, Asheim and Gertler, 2005; Bathelt *et al.*, 2004). Moreover, results reveal that regional cooperation linkages increase the likelihood of firms introducing non-technological innovation, whereas cooperation with international partners increases firms' likelihood of introducing product innovation.

1.4 Contribution and Outlook

The essays included in this dissertation contribute to the economic and regional geography literature and to the public debate on the consequences of the European integration process in several ways. The first two essays (Chapter 2 and 3) provide initial empirical evidence on the heterogeneous and multifaceted effects of the European Eastern integration process on the economic performance and public security of border regions in the old member states. They thus contribute to the literature on the economic consequences of economic integration for border regions (see, for example, Brülhart, 2011; Brülhart *et al.*, 2012) and to the literature on the effect that the removal of physical barriers has on public security (see, for example, Killias, 1993; Schwell, 2009 and 2015). Methodologically, both essays apply quasi-experimental research designs to establish causal inference. While these designs are commonly applied in regional economics (see, for example, Billmeier and Nannicini, 2013; Braakmann and Vogel, 2010; Gathmann *et al.*, 2014), they are only scarcely used in regional geography. The Synthetic Control Method (SCM) in particular, however, offers multiple possible applications in regional geographic research, where the units of analysis are commonly aggregate entities such as countries, regions or cities. By using the method in border studies, the first essay (Chapter 2) provides an application example of how the method may be applied in regional geographic research. Yet the essays also reveal where quasi-experimental designs in regional research may be constrained by the lack of available comprehensive long time series data at the regional level.

Along with their academic contribution, both essays also provide valuable input into the public debate on the consequences of the European Eastern integration process. For residents and businesses in border regions, questions about the economic consequences of economic and political integration and about the consequences of the removal of border controls on public security are relevant and quite emotional topics that are discussed

controversially in the public debate. Providing empirical evidence on these questions may help to show where concerns are justified, and public authority should do more to counteract the unintended negative consequences of the European integration process, and where concerns cannot be qualified by empirical evidence. This seems even more important in light of the ongoing xenophobic tendencies in several East German border regions revealed by high voting shares for populist or nationalist parties (Land Brandenburg, 2014). Against this background and in light of the current discussion of the future of the European Union and the Schengen Zone, the questions addressed in the first two essays could not be more current.

While both essays provide empirical evidence on the multifaceted effects of the European Eastern integration on border regions, several aspects remain unaddressed. In particular, both essays say only little about the factors that drive the regional-level effects. In future research, it may hence be worthwhile to identify factors that can explain the treatment effects on the EU Eastern enlargement 2004 and the Schengen Acquis 2007 on border regions in the old member states. It might thereby be crucial to expand the analyses to border regions on the Eastern side of the border and to evaluate the extent to which factors such as physical infrastructure, the industrial structure or wage differentials between regions on either side of the border can explain heterogeneous treatment effects. It may also be desirable to conduct sub-level analysis and identify effects at the sub-regional or municipal level. This would also increase the number of observations and help to establish asymptotic inference. Furthermore, it may be of interest to expand the empirical analysis to non-border regions that are direct or indirect neighbors of border regions. This would allow tracing the spatial dimension of the European integration effects at EU internal borders. Particularly in the second essay (Chapter 3), that examines the effects of the removal of border controls on crime rates in border regions, it may also be worthwhile to expand the time period and examine not only the immediate, but also possible medium-term effects.

The third and fourth essays (Chapter 4 and 5) provide initial empirical evidence on spatial cooperation patterns of firms in the German, rural and low-technology border region of Lower Bavaria. While firms' spatial cooperation patterns have been assessed manifoldly in the literature (see, for example, Grillitsch and Trippl, 2013 or Grillitsch and Nilsson, 2015 for recent empirical evidence), small-scaled empirical evidence for the

German context is still scarce. By disentangling the driving factors of firms' spatial cooperation patterns as well as the innovation implications that various spatial and functional cooperation configurations entail, the last two essays also contribute to the literature on the relations between cooperation and innovation outcomes of firms in peripheral, low-technology regions (Fitjar and Rodríguez-Pose, 2011; Hansen and Winther, 2011 and 2014). Both essays show that comparatively few firms cooperate with partners from the neighboring countries Austria and the Czech Republic, despite their geographic proximity. This suggests that a decade after the EU Eastern enlargement, borders remain persistent barriers to cooperation, and that the political attempts to stimulate cross-border economic networks may not have led to lasting results. This result is in line the critique of the *cross-border cooperation approach*, stating that the European integration process may not be seen as a mythical high-speed train, vaporizing any political border between the European Union member states (Van Houtum, 2000).

Despite their contributions to the literature, the last two essays both suffer from limited external validity. Hence, the detailed inquiry of Lower Bavarian firms comes at the cost that only cross-sectional data of firms from one particular region are available. This cross-sectional nature prohibits controlling for idiosyncratic region-specific or time-specific effects and exploiting variations over time and space to establish causal inference. The empirical results can therefore only depict statistically significant relations, but cannot be interpreted in a causal way. In future research, it may hence be desirable to expand the database and to compare the results of Lower Bavarian firms with the results of firms in other border or non-border regions. This would allow for an investigation of whether firms in other more or less successful border regions maintain more or fewer cooperation linkages with internal and external partners and how firms' cooperation linkages in those regions translate into innovation outcomes. Increasing the number of observations would also contribute to the establishment of asymptotic inference.

Chapter 2

The Economic Effect of the EU Eastern Enlargement on Border Regions in the Old Member States*

This essay evaluates the effect of the EU Eastern enlargement in May 2004 on the Gross Domestic Product (GDP) of border regions in the old member states. The effect is identified with the Synthetic Control Method (SCM) that allows the evaluation of the enlargement effect in a causal way. Results show that on average, no significant enlargement effect can be observed. The average effect, however, hides the fact that border regions are differently affected by the enlargement. The heterogeneous enlargement payoffs seem to be driven by the regional economic performance prior to the enlargement, the regional industrial structure and the regional endowment with physical infrastructure.

Keywords: Border Regions, Economic Integration, EU Enlargement, Synthetic Control Method

JEL Classification: F15, R10, R11

*This Chapter has profited from valuable feedback from participants of the Annual Congress of the European Regional Science Association 2015, the Annual Congress of the German Economic Association 2015 and a Workshop in Regional Economics organized by ifo Dresden in 2015.

2.1 Introduction

About a decade ago, in May 2004, eight Eastern European countries joined the European Union in the largest expansion to date. The enlargement and the concomitant implementation of the Acquis Communautaire in these countries led – with some transitional agreements – to free movement of goods, services, capital and labor between the EU-15 and its Eastern neighbors. The enlargement round in 2004 significantly increased the market size of the common market; however, it differed from previous enlargement rounds, as the wealth gap between old and new member states was more distinct. The Gross National Income (GNI) per capita measured in purchasing power parties of the new member states, for instance, amounted to merely 40% of that of the old member states, i.e. the EU-15, in 2006 (Baas and Brücker, 2010). Because of the large discrepancy in wages and socioeconomic conditions, the enlargement came not only with hopes, but also with fears about a depression of wages, increasing unemployment and, consequently, economic stagnation in the old member states (Rippl *et al.*, 2005). Particularly in regions located on the border to the new member states, businesses and employees feared increased price competition from the East, fueled by the presumption that the geographic position on the border to the new member states made these regions particularly vulnerable to competitors from the new member states (see Forster, 2007 and Trettin, 2010 for Germany). In contrast to public concerns, regional economic and geographic theories suggest that border regions ceteris paribus profit from the enlargement due to their spatial proximity to the new member states and their privileged access to the new markets (see, for example, Brülhart, 2011; Brülhart *et al.*, 2004; Niebuhr and Stiller, 2002 for an overview).

Despite these theoretical contributions, empirical evidence on the question of the economic consequences of the EU Eastern enlargement for border regions in the old member states is scarce. The majority of empirical studies that assess the consequences of the enlargement round focus on the EU-wide impact or on economic effects on the country level in both old (see, for example, Baas and Brücker, 2010 and Dauth *et al.*, 2014) and new (see, for example, Elsner, 2013a and 2013b) member states. Few address the peculiarities of border regions, even though they were assumed to be focal points in the integration process (European Commission, 2001; Resmini, 2003). The few studies that do empha-

size on the enlargement effects in border regions in the old member states predominantly focus on selected border regions and investigate the factors that facilitate or hinder cross-border cooperation (see, for example, Knippschild, 2011; Krätke, 2002; Krätke and Borst, 2007; Leick, 2010; Xheneti *et al.*, 2013). While these studies provide initial empirical evidence on the behavioral strategies of regional economic actors, their external and internal validity is comparatively low: firstly, they only investigate the consequences of the enlargement in selected border regions, which prohibits general conclusions on all border regions; and secondly, the studies do not consider the counterfactual situation, i.e. the situation had the EU Eastern enlargement not taken place.

This essay aims to contribute to the literature by identifying the economic effect of the EU Eastern enlargement on border regions in the old member states in a causal way. It does so by applying the Synthetic Control Method (SCM) that was introduced by Abadie and Gardeazabal (2003) and refined by Abadie *et al.* (2010 and 2015). Basically, the SCM compares the economic development of each border region in the years after the EU Eastern enlargement with the economic development of synthetically generated controls that approximate the counterfactual situation, i.e. the hypothetical economic performance of the border regions had the EU Eastern enlargement not taken place. The approach allows the identification of the treatment effect of the EU Eastern enlargement for each border region individually and the evaluation of the Average Treatment effect on the Treated (ATT), i.e. the average enlargement effect over all border regions. By choosing a relatively long time period of eight years after the enlargement, the empirical analysis also accounts for the fact that cross-border cooperation needs some time to emerge and that the enlargement effects may only unfold in the medium term.

Results indicate that on average, a negative enlargement effect can be observed. The effect is, however, not statistically significant and is mainly driven by the two capital regions of Berlin and Vienna. When excluding these two regions from the analysis, a positive enlargement effect is visible in the medium term. This finding supports the presumption that regions with inherently better access to new markets can profit from economic integration (see, for example, Brülhart *et al.*, 2004; Niebuhr and Stiller, 2002).

When looking at the enlargement effects in the individual border regions, it becomes evident that border regions are differently affected by the enlargement and that heterogeneous enlargement payoffs can be observed. Descriptive evidence suggests that rural border regions with a comparatively high regional GDP in the years prior to the enlargement have predominantly profited from the enlargement, while rural border regions with a comparatively weaker economic performance prior to the enlargement could not capitalize on the enlargement to the same extent. For urban regions, however, the opposite seems to be the case. Here, economically successful urban regions reveal negative treatment effects, whereas urban regions characterized by a lower economic performance in the years prior to the enlargement experienced positive enlargement effects. As it will be shown below, these effects may, however, be confounded by several intervening factors. When quantitatively assessing the drivers of the heterogeneous treatment effect, the regional employment rate, the strength of the industrial sector and the regional endowment with physical infrastructure positively correlate with the regional enlargement payoff. Translated into the political context, the findings suggest that one-size-fits-all policy solutions are not appropriate. Instead, regional growth policies in regions bordering the new member states should pursue place-based solutions that consider regional characteristics.

The remainder of the essay is structured as follows: Section 2.2 sketches the regional economic and geographic theories on the spatial effects of economic integration and outlines the existing empirical evidence. Section 2.3 introduces the key characteristics of the 15 border regions and classifies these regions according to their settlement structure and economic performance. Section 2.4 introduces the research design and the regional data, while Section 2.5 outlines the results from the empirical analysis. The essay closes with a critical discussion of the results in Section 2.6.

2.2 Spatial Effect of Economic Integration - Theory and Empirical Evidence

In the literature, the effects of economic integration on border regions have not yet been conclusively assessed. Hence, it is still unclear whether regions located on the border to newly integrated countries have been particularly affected by the integration process, and whether the potential integration effect is positive or negative (Brülhart, 2011; Petrakos and Topaloglou, 2008). In regional economic and geographic theory, spatial effects of economic integration have traditionally been assessed in classic trade and location theories (Niebuhr and Stiller, 2002). Trade theories assume that spatial effects of economic integration emerge as a result of intra-country factor reallocation. Regions with inherently better access to new markets such as port cities and border regions are assumed to profit from an increase in international trade flows (Rauch, 1991). Hence, these regions can attract exporting firms due to their proximity to the new markets and the presumably lower access costs. The increase in economic activities may then translate into a positive regional economic performance (see Capello, 2007 and Niebuhr and Stiller, 2002). While trade theories primarily focus on the trading of goods, they also apply for the trading of services that has also been implemented through the EU enlargement and the ratification of the Acquis Communautaire in the Eastern European member states.

In contrast to trade theories that deal with the consequences of international trade flows for the regional factor reallocation within a country, classic location theories explicitly focus on the geographic location decisions of firms and view trade flows as a consequence of these location decisions (Niebuhr and Stiller, 2002). Based on the classic location models of Lösch (1944) and Giersch (1950), location theories presume that the location decisions of firms are determined by the size of the market for goods and services that they can serve. As borders constitute barriers to free flows of goods and services, they constrain the accessible market area of firms located in these regions. Hence, they are less attractive location sites for firms (see Capello, 2007; Niebuhr and Stiller, 2002 for an overview). When free movement of goods and services is implemented, borders no longer constitute barriers to factor flows. This increases the market potential of firms in border regions. As a consequence, border regions may gain in attractiveness due to privileged access to the new markets (Niebuhr, 2008).

New Economic Geography (NEG) models integrate considerations of both trade and location theories. NEG models were initially introduced by Krugman (1991) in his seminal core-periphery model and have been modified and extended by Krugman and other authors since then (Niebuhr and Stiller, 2002). The models explain regional disparities in economic activities by endogenous location decisions of both firms and employees (see Capello, 2007 and Niebuhr and Stiller, 2002 for an overview). Since economic integration facilitates cross-border factor movement and decreases cross-border transportation costs, it is assumed to affect the regional distribution of economic activities in favor of border regions. This assumption is tested in various theoretical applications of NEG models. Brülhart *et al.* (2004) and Crozet and Koenig (2004), for instance, trace explicitly what happens to the spatial distribution of economic activities within a country when cross-border transaction costs decrease. Their theoretical models predict that border regions ceteris paribus realize the largest gains from economic integration. While Brülhart *et al.* (2004) attribute this to a concentration of human capital in border regions, Crozet and Koenig (2004) predict that trade liberalization drives domestic firms to regions close to the border, unless competition is too strong. Their results are mirrored in other models, leading Brülhart (2011) to conclude that the available NEG models predict that regions with inherently less costly access to foreign markets, such as border or port regions, ceteris paribus realize the largest gains from economic integration.

Despite these theoretical contributions, empirical evidence on the topic is comparatively scarce. Niebuhr and Stiller (2002) provide a comprehensive overview of earlier empirical works that assess the effect of economic integration on border regions for the European as well as North American context. The majority of these studies apply gravity models to estimate the magnitude of border effects on cross-border flows of economic activities (see, for example, Head and Mayer, 2000 and Nitsch, 2000 for the European context), or focus on the cross-border business linkages of firms in selected border regions (see, for example, Krätke and Borst, 2007 and Leick, 2010 for Germany). While these studies provide initial empirical evidence on border effects as well as on the factors that facilitate or hinder cross-border economic activities, they do not evaluate the effects of changes in market access on border regions in a causal way.

In the past decade, however, several studies have been conducted that apply quasi-experimental research designs in order to identify the causal effects of economic inte-

gration. Redding and Sturm (2008), for instance, evaluate the effect of the German separation on West German cities located close to the inner German border. They find that these cities experienced a decline in population and economic performance once the border was established. Focusing on Austrian border regions, Brülhart *et al.* (2012) identify a significant effect on regional employment rates and wages in border regions after the fall of the Iron Curtain. With respect to the various EU enlargement rounds, Brakman *et al.* (2012), reveal positive enlargement effects on population size in border regions on either side of the inner European borders. In a quasi-experimental study that focuses explicitly on the effects of the EU Eastern enlargement in 2004 on border regions, Braakmann and Vogel (2010) show that small service firms located in German Federal States bordering Poland or the Czech Republic profited from the EU Eastern enlargement, while large firms did not profit, at least in the years immediately after the EU Eastern enlargement.

While these studies differ in the estimation strategy, the regional context and the outcome variable, they still predominantly support the hypothesis that border regions (or firms located in these regions) are positively affected by economic integration. Yet it would also be plausible to find no or negative integration effects in border regions. This assumption is supported by the fact that border regions may systematically differ from core regions in characteristics other than the geographic location. Hence, border regions often constitute peripheral, low-opportunity areas, characterized by lower population densities and the lack of any major regional agglomeration center (Krätke and Borst, 2007; Petrakos and Topaloglou, 2008). Consequently, they may lack the resources to exploit integration benefits with which urban systems are endowed (Duranton and Puga, 2004). Moreover, they may be less well integrated into international trade and knowledge flows that commonly take place between global hubs (Bathelt *et al.*, 2004; Krätke and Borst, 2007). Less innovative border regions in particular, which compete predominantly via price, may suffer from the increased international competition, reducing the attractiveness of these regions as production sites (Niebuhr, 2008; Topaloglou *et al.*, 2006). Moreover, these less innovative regions are commonly insufficiently endowment with cognitive capital, which may hamper their capability to fully exploit new knowledge that is circulated by increased factor mobility (Caragliu and Nijkamp, 2012; Cohen and Levinthal, 1990).

Overall, these arguments suggest that there may be certain regional characteristics that could prevent border regions from profiting from economic integration, despite their spatial proximity to the new member states. At the same time, the arguments indicate that the effects of the EU economic integration may vary across border regions, depending on integral characteristics of these regions such as their economic performance, their settlement structure, their stock of human capital or their innovativeness. As it will be shown below, the Austrian, German and Italian regions located on the border to the new member states inevitably differ in their regional characteristics, suggesting that they have been differently affected by EU Eastern enlargement of 2004.

2.3 Border Regions in the EU-15

To learn more about the border regions at the frontier to the new member states, this section clusters the Austrian, Italian and German border regions according their settlement structure and economic performance in the years prior to the EU enlargement in 2004. Overall, the treatment group consists of all EU-15 regions at the second level of the Nomenclature des Unités Territoriales Statistiques of 2006 (NUTS-2 level of 2006) that share a border with any of the new member states. Even though lower levels of analysis such as the NUTS-3 or municipal level would facilitate the isolation of the immanent border effect (see Brülhart *et al.*, 2012 for a thorough discussion), in this essay, the NUTS-2 level is used as the level of analysis. This level is chosen, because for several regional covariates long time-series data is only available at this higher aggregated level. Moreover, in Germany, several regional borders at the NUTS-3 level changed in the course of local government reorganization, affecting in particular border regions in Saxony and Mecklenburg-Western Pomerania. This would further aggravate the analysis at the NUTS-3 level for German border regions.

Figure 2.1 maps the 13 regions that are located on the border to the new member states. Precisely, these are the five Austrian regions Upper Austria, Lower Austria, Burgenland, Styria and Carinthia that share a border with either Slovenia, Hungary, Slovakia or the Czech Republic, the Italian region of Friuli-Venezia Giulia, which borders Slovenia, and the seven German border regions Mecklenburg-Western Pomerania, Brandenburg, Dresden, Chemnitz, Upper Franconia, Upper Palatinate and Lower Bavaria, which share a border with either Poland or the Czech Republic.

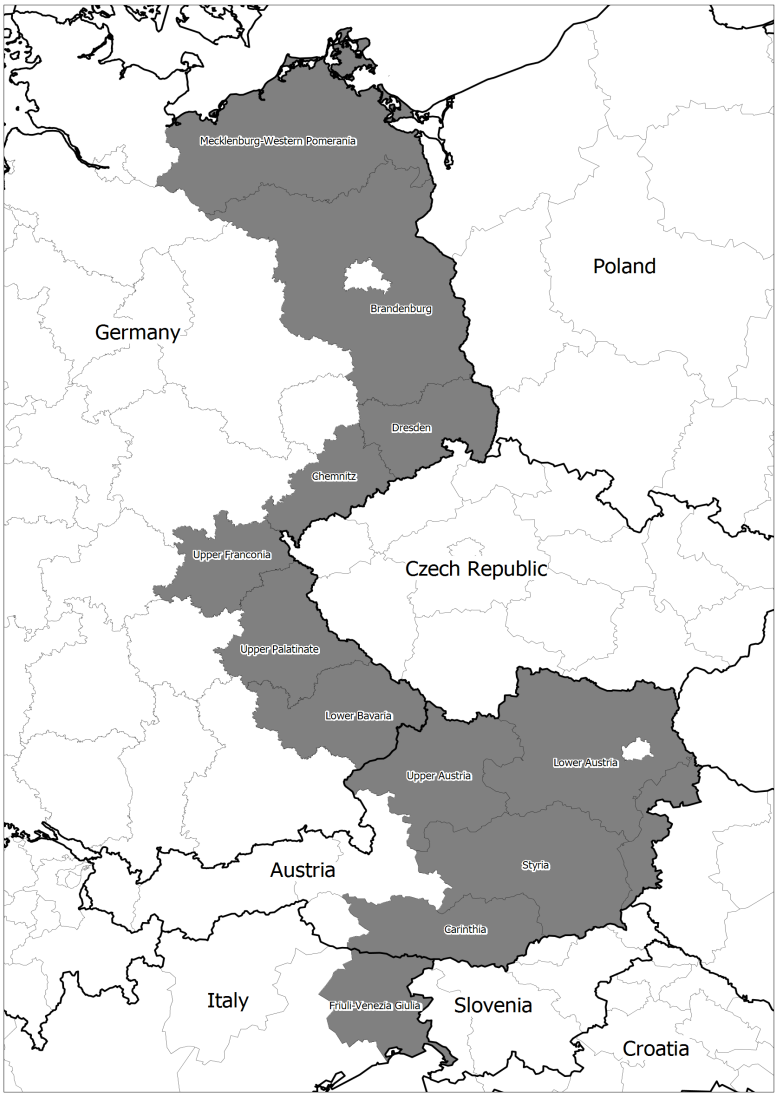


Figure 2.1: NUTS-2 Regions on the Border to the New Member States
The map depicts German, Austrian and Italian border regions located at the border to the new member states at the NUTS-2 level of 2006.

Of the German regions, Mecklenburg-Western Pomerania, Brandenburg, Dresden and Chemnitz are located in the East of Germany, the former German Democratic Republic (GDR). The economic trajectory of these regions in the 1990s, therefore, differs from the remaining EU-15 regions. Along with these 13 regions, the two capital regions of Berlin and Vienna are also treated as border regions, given their proximity to the new member states and their location within a NUTS-2 border region. The consideration of these two capital regions also enables a comparison between the enlargement effect on rural, peripheral border regions and metropolitan centers close to the border.

In the following, the 15 NUTS-2 regions that form the treatment group are clustered according to the regional settlement structure and the regional economic performance in the four years before the EU Eastern enlargement, i.e. from 2000 to 2004 (see Table 2.1). While the regional settlement structure may serve as a proxy for the presence of regional agglomerations, the regional GDP per capita serves as an indicator of the overall regional economic context. Both take up the assumption that border regions with a higher population density and border regions with a stronger economic performance are more capable of exploiting new market potentials, an argument that can also be found in Krätke and Borst (2007) and Petrakos and Topaloglou (2008).

Table 2.1: Typology of EU-15 Regions on the Border to the New Member States[a]

	High GDP	Low GDP
Agglomration Center and Urban Regions	Berlin Vienna Friuli-Venezia Giulia Upper Franconia	Dresden Chemnitz
Rural Regions	Upper Palatinate Lower Bavaria Styria Upper Austria Lower Austria Carinthia	Brandenburg M.-W. Pomerania Burgenland

[a] Thresholds are as follows: 150 inhabitants per squared kilometer for the regional settlement structure; GDP above 75% of the EU-15 average for the regional economic performance. Data are obtained from the Eurostat Regional Database (Eurostat, 2016).

Regarding the regional settlement structure, the two capital regions of Berlin and Vienna stand out from the remaining border regions. Hence, both regions are characterized by very high population densities of around 4,000 inhabitants per square kilometer in the four years prior to the EU Eastern enlargement. Consequently, both regions classify as agglomeration centers according to the official classification of the German Federal Institute for Research on Building, Urban Affairs and Spatial Development (Bundesinstitut für Bau-, Stadt- und Raumforschung, BBSR, 2014). Along with the two capital regions, the two East German regions of Chemnitz and Dresden are also among the more densely populated border regions with a population density above 200 inhabitants per square kilometer. Together with the Italian region of Friuli-Venezia Giulia and the German region of Upper Franconia, which both reveal population densities above 150 inhabitants per square kilometer, they classify as urban regions according to the BBSR classification (Bundesinstitut für Bau-, Stadt- und Raumforschung, 2014). Among the rural regions, i.e. regions with a population density below 150 inhabitants, the Austrian region of Upper Austria and the German regions of Lower Bavaria and Upper Palatinate are the most densely populated regions. These regions revealed population densities of between 110 and 115 inhabitants per square kilometers in the pre-enlargement period. The remaining border regions are all characterized by population densities below 100 inhabitants per square kilometer.

In terms of regional economic performance, the 5-year average of the regional GDP per capita for the years prior to the enlargement, i.e. 2000 to 2004, is highest in the Austrian capital region of Vienna, followed by the Austrian region of Upper Austria and the Italian region of Friuli-Venezia Giulia. In the same years, the four border regions located in East Germany, namely Chemnitz, Dresden, Mecklenburg-Western Pomerania and Brandenburg, realized the lowest GDP per capita. These four regions also qualified as Objective 1 regions in the European structural funds programming period 2000 to 2006 (European Commission, 2015). Along with the four East German regions, the Austrian border region Burgenland also qualified as an Objective 1 region, i.e. as a region with a GDP below 75% of the EU-15 average (European Commission, 2015). All other border regions reveal GDPs per capita above the 75% community average in the years prior to the enlargement.

When classifying the border regions according to their settlement structure and economic performance, it becomes evident that rural regions prevail (see Table 2.1). The economically stronger rural border regions include the Austrian regions of Upper Austria, Lower Austria, Styria and Carinthia as well as the German border regions of Upper Palatinate and Lower Bavaria that are both located in the Federal State of Bavaria. The group of economically weaker rural border regions includes the two East German border regions of Brandenburg and Mecklenburg-Western Pomerania and the Austrian region of Burgenland. Given their less favorable regional characteristics, it may be plausible to assume that these regions may not profit from the EU Eastern enlargement to the same extent that economically stronger regions do. Among the agglomeration centers and urban regions, three types can be identified: firstly the two capital regions of Vienna and Berlin, secondly the Italian region of Friuli-Venezia Giulia and the German region of Upper Franconia, and thirdly the two East German regions of Dresden and Chemnitz that have qualified as Objective 1 regions in the EU structural funds programming period 2000 to 2006.

2.4 Research Design

To evaluate the economic effect of the EU Eastern enlargement in 2004 on border regions in a causal way, the enlargement is thought of as an exogenous change to cross-border factor mobility that affected border regions notably more than non-border regions given their geographic proximity to the new member states. The EU Eastern enlargement in 2004 was the final step in a long integration process initiated in the early 1990s that had led to gradual trade liberalization and may hence have been anticipated by regional economic actors. However, the actual consequences of the enlargement only became noticeable in May 2004, when the Acquis Communitaire was fully implemented in the Eastern European member states, enabling free flows of goods, services, capital and labor as well as the full adoption of the common legal framework[1] (Epstein and Jacoby, 2014). The adoption of the common legal framework reduced legal barriers as well as formal non-tariff barriers to cross-border economic interaction such as rules of origin, import licensing, or technical regulations. The EU 2004 enlargement hence exceeded earlier

[1]Except for some transition agreements on labor migration in Germany and Austria.

trade agreements that merely dealt with the reduction of tariffs or trade quotas for goods. Given these institutional changes, it is plausible to treat the EU Eastern enlargement as an external change to market access that particularly affected regions located directly on the border to the new member states. As these regions were exogenously selected into the treatment group because of their geographic location and because their selection into the treatment group is stable over time, the EU Eastern enlargement may be thought of as a setting akin to a natural experiment.

2.4.1 The Synthetic Control Method

In the empirical analysis, the economic effects of the EU Eastern enlargement on the individual border regions in the old member states are identified and evaluated with the Synthetic Control Method (SCM). The SCM was introduced by Abadie and Gardeazabal (2003) and modified and extended by Abadie *et al.* (2010 and 2015). It constitutes an alternative method for evaluating the effect of an event or intervention that takes place at an aggregate level and affects aggregate entities (Abadie *et al.*, 2010). Basically, the SCM compares the outcome of interest (in this case the regional GDP per capita) after an event of interest (in this case the EU Eastern enlargement in 2004) in the entity affected by the event (in this case a border region) with the outcome of a weighted combination of unaffected entities (in this case a weighted combination of non-border regions) (Abadie *et al.*, 2010). This combination constitutes the so-called synthetic control. The weight for the unaffected units are chosen so that the entities included in the synthetic control best approximate the performance of the affected entity over an extended period of time prior to the event of interest (Abadie *et al.*, 2010). The idea of the SCM is that when both affected entities and their synthetic controls behave similarly over an extended period of time prior to the event of interest, then any discrepancy in the outcome variable after the event of interest can be ascribed to the event itself; therefore, the discrepancy can be interpreted as the causal effect of the event or intervention of interest (see Abadie *et al.* 2010 and 2015 for a detailed discussion of the SCM). The intuition behind the SCM is comparable to the statistical matching approach and may be thought of as a treatment-control design, as it compares the outcomes of treated units, i.e. border regions, and otherwise similar but untreated units, i.e. combinations of non-border regions. The dis-

crepancy in the outcome variable between treated units and their corresponding synthetic controls can then be interpreted as the treatment effect on the treated. Given that Y_{jt}^{B} denotes the outcome, i.e. regional GDP per capita (in Euro in 2005 prices) observed for border region j in the post-enlargement period t and Y_{jt}^{SC} denotes the outcome observed for the synthetic control of border region j at time t for border regions $j = 1 \dots J$ and time period $t = 1, \dots T$, the treatment effect for each border region is the following:

$$\Delta = Y_{jt}^{B} - Y_{jt}^{SC}$$

Consequently, the weighted average of the discrepancy between all border regions and their synthetic controls constitute the Average Treatment effect of the Treated (ATT), whereby w_j reflects the weight attached to each of the border regions, so that larger border regions contribute to the ATT more than smaller ones:

$$\Delta = E[w_j(Y_{jt}^{B} - Y_{jt}^{SC})]$$

2.4.1.1 The Donor Pool

As indicated above, in the context of the EU Eastern enlargement, the treatment group includes the 13 border regions located on the border to the new member states and the two capital regions Berlin and Vienna. The remaining 199 European NUTS-2 regions in the EU-15 constitute potential control units. They form the so-called donor pool. The identification of the donor pool, i.e. the selection of regions that may constitute potential controls, is highly important: if the regions included in the donor pool are not sufficiently similar to the border regions, then any differences in outcomes between border regions and their synthetic controls may merely indicate disparities in their regional characteristics (Abadie *et al.*, 2015). Therefore, regions with geographic peculiarities are a priori excluded from the donor pool. This applies to the French overseas departments, the Spanish regions of Ceuta and Melilla, as well as to insular regions in France (Corsica), Spain (Balearics and Canaries), Portugal (Azores and Madeira) and Finland (Aland). Moreover, all Greek regions are also excluded because of a lack of data availability.

Along with this baseline configuration, three alternative configurations of the donor pool are tested for robustness. In the first alternative configuration, all regions that constitute immediate neighbors to the 13 border regions are also excluded from the donor pool to account for direct spatial spillover effects. In the second configuration, only NUTS-2 regions located in EU-6 countries, i.e. in Belgium, France, Germany, Italy, Luxembourg and the Netherlands are included in the donor pool. This accounts for possible integration effects from previous enlargement rounds. In the third configuration, all regions located on EU inner borders, for instance regions located on the French-German or Spanish-Portuguese border, and all regions located on the coast are excluded from the donor pool in order to isolate the border effect better. The overall results do not change when using these alternative donor pool configurations. Yet the match between the border regions and their synthetic controls deteriorates in these alternative configurations of the donor pool. Given this caveat, the reported results are based on the more encompassing donor pool of all EU-15 non-border regions, excluding the regions with regional peculiarities outlined above.

2.4.1.2 The Synthetic Controls

Having identified the donor pool, in the second step, for each of the 13 border regions and the two capital regions individual synthetic controls are generated. Technically, the synthetic controls are generated as weighted averages of non-border regions included in the donor pool, whereby the synthetic control can be represented by a $(J \times 1)$ vector of weights $W = (w_1, \ldots, w_J)'$, with $0 \leq w_j \leq 1$ for $j = 1, \ldots J$ non-border regions and $w_1 + \cdots + w_J = 1$ (Abadie *et al.*, 2010 and 2015). The weights for the regions included in the donor pool are selected by an algorithm based on the similarity of the border region with the regions included in the donor pool before the enlargement with respect to past realizations of the regional GDP per capita and several GDP predictor variables. In the analysis, the pre-enlargement period encompasses 13 years, i.e. the time period from 1991 to 2003. This observation period is given by the availability of regional data. The generation of the synthetic control is conducted using the *synth* package for Stata, developed and made available by Abadie *et al.* (2015). As the construction of a suitable comparison group, i.e. synthetic control, is based on a data-driven procedure, discretion in the choice of the comparison control units is reduced and inference is possible (Abadie

and Gardeazabal, 2003; Abadie *et al.*, 2010).

For the GDP-predictor variables, a parsimonious set of standard economic performance predictor variables is used. The set includes variables that are commonly identified in the literature to affect a region's economic performance (see, for example, Cuaresma-Crespo *et al.*, 2014).

Table 2.2: GDP Predictor Variables for SCM[a]

Variable	Description
Dependent Variable:	
Regional GDP	GDP per capita in Euro in 2005 prices
GDP Predictor Variables:	
Population Density	Number of inhabitants per squared kilometer
Income Level	Average regional hourly wage in Euro in 2005 prices
Primary Sector	Share of agricultural sector (NACE Rev.2 A) on regional GVA
Secondary Sector	Share of industrial sector (NACE Rev.2 B-F) on regional GVA
Teritiary Sector	Share of service sector (NACE Rev.2 G-U) on regional GVA
Employment Rate	Share of employees on the regional active population
Patent Intensity	Number of patents reportet to EPO per 1,000 employees
GDP in 1991	GDP per capita in 1991 in Euro in 2005 prices
GDP in 1995	GDP per capita in 1995 in Euro in 2005 prices
GDP in 2000	GDP per capita in 2000 in Euro in 2005 prices

[a] Data are obtained from the Cambridge Econometric Regional Database (2015) and the Eurostat Regional Database (2016). EPO= European Patent Office; GVA=Gross Value Added; NACE=Nomenclature statistique des Activités économiques dans la Communauté Européenne (European Industrial Activity Classification).

Basically, three groups of predictor variables are taken into account: firstly variables that reflect the regional factor allocation such as the regional population density and the regional income level. These variables indicate the regional economic potential and should positively affect the regional GDP per capita. The second group of factors reflects the regional sectoral structure, and includes the share of the primary, secondary and tertiary sector of the economy on the regional Gross Value Added (GVA). Furthermore, the regional endowment with human capital, measured through the regional employment rate, and the regional innovativeness, approximated through regional patent intensity, are included as further factors that affect the regional endogenous growth potential and, consequently, the regional economic performance[2]. Furthermore, for three years (1991,

[2]The list is not conclusive and factors such as the share of employees with tertiary education and the share of human resources in science and technology are also important. However, for several possible covariates, time-series data for the years 1991 to 2000 are not available at the NUTS-2 level, which restricts the set of possible regional covariates.

1995 and 2000) the pre-enlargement regional GDP per capita are included as a fourth group of variables to account for inertia and path-dependency in the regional economic development. Data on the regional characteristics are obtained from the Cambridge Econometrics Regional Database (2015) and the Eurostat Regional Database (2016). Table 2.2 provides a comprehensive overview of the GDP predictor variables used to generate the synthetic controls of the border regions.

One advantage of the SCM compared to standard panel regression is that the SCM makes explicit the relative contribution of each control unit to the synthetic control (Abadie *et al.*, 2010 and 2015). The Tables in Appendix I, Part I.1 list the regions and their corresponding weights that are included in the synthetic controls of the individual border regions. As becomes evident, of all EU-15 regions included in the donor pool, six to ten regions contribute to the synthetic controls of the individual border regions. Only for the capital city of Berlin as well as for Chemnitz is the number of regions that contribute to the synthetic control lower. This may result from the peculiar development of both regions during the 1990s due to their GDR legacy. When comparing the GDP predictor means in the pre-enlargement period of the border regions and their synthetic controls, it becomes evident that the values of GDP predictors in the pre-enlargement period of the synthetic controls match the values of the border regions quite well (see Tables in Appendix I, Part I.1). Only for population density do the values between the border regions and their synthetic controls differ in several border regions and their corresponding synthetic controls. For the remaining variables, the values of the border regions are close to the values of the synthetic controls in the pre-enlargement period, suggesting that any discrepancy in the economic performance of border regions and their synthetic controls in the post-enlargement period may indeed be attributed to the EU Eastern enlargement.

For the SCM to work, two identification assumptions must hold: firstly, the choice of pre-treatment characteristics should include variables that can approximate the path of the treated region, and secondly, the regions used to create the synthetic control, i.e. the donor pool, should not be affected by the treatment (Campos *et al.*, 2014). The first assumption can be tested by indicating the correlations between the GDP predictor variables and the regional GDP. As Table 2.3 shows, all GDP predictor variables under consideration sufficiently correlate with the regional GDP per capita. In contrast, the

second assumption, also known as the Stable Unit Treatment Value Assumption (SUTVA) or non-macro effect assumption, is more difficult to justify in the context of the EU Eastern enlargement of 2004. Hence, the EU enlargement also undeniably affects other regions, and the SUTVA may be violated. Empirical results can thus only be interpreted as lower bonds of the true effects[3]

Table 2.3: Correlation between Regional GDP and Regional Covariates[a]

Regional Covariates	Correlation coefficient
Population Density	.506
Employment Rate	.464
Patent Intensity	.397
Industrial Sector	-.211
Service Sector	.347
Agricultural Sector	-.373
Income Level	.816

[a] Correlation coefficients between GDP per capita and various regional covariates based on a pooled sample of EU-15 regions (NUTS-2) for the years 1980 to 2012. For the East German regions, only the years from 1991 onward are included.

2.5 Empirical Results

The following section reports the average enlargement effect on the GDP per capita of border regions in the old member states as well as the individual enlargement effects in each of the 13 border regions and the two capital cities Berlin and Vienna. This juxtaposition allows for an evaluation of the overall enlargement effect and an examination of whether the effects are homogeneous across all types of border regions or whether heterogeneous enlargement effects are at play.

[3]To account for potential spill over effects, regions that constitute immediate neighbors to the border regions were excluded from the donor pool in an alternative configuration of this pool. When using this alternative donor pool, results remain similar except for the East German regions for which immediate neighbors constitute important control regions.

2.5.1 Average Effect

Figure 2.2 depicts the weighted average of the regional GDP per capita of all 13 border regions and the two capital cities for the years from 1991 to 2012 as well as the weighted average of the corresponding synthetic controls. Both series are generated with weights corresponding to the size of the regional labor force, measured by the number of employees. This allows to account for the size of the regions and their relative contribution to the average of all border regions.

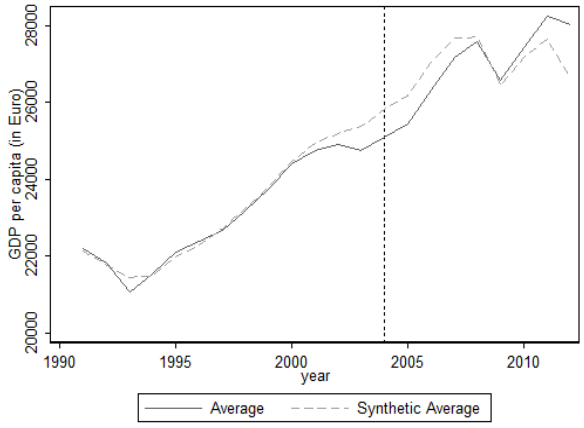


Figure 2.2: Trends in Regional GDP per capita Including Berlin and Vienna
Weighted average of border regions vs. weighted average of corresponding synthetic controls

The two series show a similar trend until 2000; from 2000 onward, however, the average of the synthetic controls shows a more favorable economic development than the average of the border regions. This suggests that border regions could not capitalize from the EU Eastern enlargement despite their geographic location on the border to the new markets. In contrast, the graphs suggest that border regions actually suffered from the EU Eastern enlargement, as their economic performance developed less favorably than that of their synthetic counterparts. However, as will be shown below, this result is strongly driven by the two capital regions of Berlin and Vienna that are both negatively affected by the enlargement. Therefore, in the second step, the two capital regions are excluded from the analysis. When excluding the two capital cities, the two series show a similar trend in the years immediately after the EU Eastern enlargement (see Figure 2.3). However, from 2007 onwards, the weighted average of all border regions (excluding Berlin and Vienna) reveals a better economic performance than the corresponding synthetic control, suggesting that

in the medium term, border regions (excluding the capital cities Berlin and Vienna) have experienced a more favorable development in the years after the EU Eastern enlargement than they would have had the enlargement not taken place. This finding is in line with regional economic theories, assuming that ceteris paribus regions with inherently better access to new markets profit from economic integration (see Brülhart, 2011 for an overview). The time lag in the enlargement effect may result from the fact that the institutionalization of cross-border cooperation does not happen overnight, but requires some time to emerge[4].

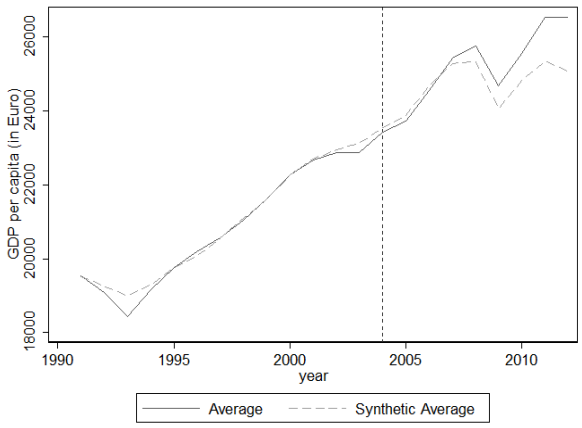


Figure 2.3: Trends in Regional GDP per capita Excluding Berlin and Vienna
Weighted average of border regions vs. weighted average of corresponding synthetic controls

The difference in short-term and medium-term adjustment also becomes evident when looking at the magnitude of the effect listed in Table 2.4. The table entries denote the difference (in %) in GDP per capita between border regions and their corresponding synthetic controls in the years after the EU Eastern enlargement. The first column shows the magnitude of changes for the first four years after the EU enlargement, i.e. the average change for the years 2004 to 2008, while the second column reports the magnitude of changes for the first eight years after the enlargement, i.e. the average change for the years 2004 to 2012. The values show that when including Berlin and Vienna, in the short term, the enlargement effect is negative, amounting to -1.94%. In the medium term,

[4]Another interpretation would relate to the recent economic crisis, potentially affecting border regions less severe than their synthetic controls. However, from a theoretical point of view, the economic crisis should affect both border and non-border regions. Moreover, as Figure 2.3 shows, the difference in border regions and their synthetic controls already emerges in 2007, i.e. a year before the crisis hit. Yet, in the medium term, potential confounding effects from the crisis cannot be ruled out completely.

however, the effect is slightly positive and amounts to 0.11%. When excluding the two capital cities, the effect is positive and amounts to 0.26% in the short term and to 2.21% in the medium term.

Table 2.4: Magnitude of the Enlargement Effect in the Short and Medium Run

	Difference in post-enlargement average GDP per capita (in %) between Border Region and Synthetic Control	
	Average effect 4 years after Eastern Enlargement	Average effect 8 years after Eastern Enlargement
Average with Vienna and Berlin	-1.94	0.11
Average without Vienna and Berlin	0.26	2.21
Burgenland	0.33	2.67
Lower Austria	-0.42	2.13
Carinthia	1.64	3.45
Styria	3.18	3.36
Upper Austria	1.10	2.90
Vienna	-3.94	-2.35
Berlin	-9.30	-7.60
Lower Bavaria	0.02	5.43
Upper Palatinate	-0.28	4.02
Upper Franconia	-3.36	0.24
Brandenburg	-0.88	-2.13
Mecklenburg-Western Pomerania	-1.99	0.87
Dresden	3.91	6.90
Chemnitz	6.53	5.84
Friuli-Venezia Giulia	-1.49	-4.62

The relatively small magnitudes of the effects suggest that overall, the enlargement affected the economic performance of border regions only slightly. In the second step, it is now crucial to investigate the confidence attached to the estimated effects. There is, however, no accepted way to date of carrying out standard hypothesis tests when applying the SCM (see Abadie *et al.*, 2010; Campos *et al.*, 2014). One strategy to attain confidence about the level of statistical significance of the effects is to access the average differences in the economic development of border regions and their synthetic controls before and after the EU Eastern enlargement. This strategy has been proposed by Campos *et al.* (2014). Precisely, a linear difference-in-difference model is estimated that reveals the statistical significance of the differential between the average difference between the actual economic performance of the border regions and their corresponding synthetic controls prior to the enlargement, and their average difference in the post-enlargement period. Table 2.5 indicates the level of statistical significance of the differences in the two series. It becomes evident that for the weighted average of all border regions (including the two capital regions Berlin and Vienna), the estimated DID coefficient is not statistically significant.

This implies that on average, i.e. when taking all border regions together, border regions do not reveal a significantly higher or lower GDP per capita after the EU enlargement than they would have, had the EU enlargement not taken place. This finding suggests that in contrast to public concerns, on average, border regions in the old member states have not been the losers of the EU Eastern enlargement. When excluding the two capital cities of Berlin and Vienna, the DID coefficient is not statistically significant, either.

Table 2.5: Difference-in-Difference Estimates of EU Eastern Enlargement[a]

	GDP per capita (in 2005 Euro)	
	DiD estimate	R^2
	Std. error	N
Average with Vienna and Berlin	178.31	.69
	(805.05)	44
Average without Vienna and Berlin	618.32	.68
	(882.46)	44
Burgenland	530.94	.55
	(1051.64)	44
Lower Austria	522.45	.63
	(962.30)	44
Carinthia	962.70	.65
	(1046.06)	44
Styria	940.93	.62
	(1254.17)	44
Upper Austria	1002.43	.67
	(1242.49)	44
Vienna	-778.09	.51
	(1640.95)	44
Berlin	-1800.00**	.54
	(670.18)	44
Lower Bavaria	1616.926	.61
	(1216.76)	44
Upper Palatinate	1407.67	.61
	(1374.96)	44
Upper Franconia	61.32	.71
	(771.27)	44
Brandenburg	-260.45	.69
	(723.94)	44
Mecklenburg-Western Pomerania	404.90	.68
	(605.11)	44
Dresden	922.79	.67
	(758.79)	44
Chemnitz	1504.47*	.72
	(746.01)	44
Friuli-Venezia Giulia	-1100.00	.28
	(1027.16)	44

[a] Table entries denote the statistical significance of the difference between the average difference before the enlargement, i.e. 1991-2003 (between the border region and its synthetic control) and the average difference after the enlargement, i.e. 2004-2012 (between the border regions and its synthetic control). Results are presented for each region and for the two weighted averages. Robust standard errors in parentheses. Inference: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

2.5.2 Regional Effects

So far, the results have shown that on average, border regions did not reveal a significantly higher or lower GDP in the years following the EU enlargement than they would have had the enlargement not taken place. Yet the weighted average over all regions does not say anything about the effects at the regional level. As outlined above, it is plausible that economically successful regions are better equipped to profit from changes in market access, whereas economically weaker regions may lack the resources to capitalize on the enlargement. To draw conclusions about the enlargement effects in the individual border regions, the enlargement effects are identified now for each border region individually.

The graphs in Figure 2.4 display the actual GDP per capita of the 13 border regions and the two capital cities Berlin and Vienna between 1991 and 2012 and the trends of the corresponding synthetic controls. The graphs reveal that several rural, economically successful border regions such as the Austrian regions of Upper Austria, Styria and Carinthia and the German region of Lower Bavaria show a more positive development in the post-enlargement period than their corresponding synthetic controls, indicating that this group of regions could profit from the enlargement. For the German region of Upper Palatinate and the Austrian region of Lower Austria, which also qualify as economically more successful rural regions, the effect is negative, however. Yet, when looking at the magnitude of the effects displayed in Table 2.4, it becomes evident that in each of these region, the enlargement effect is positive in the medium run. As Table 2.5 denotes, effects are, however, not statistically significant for any of the rural, economically successful regions.

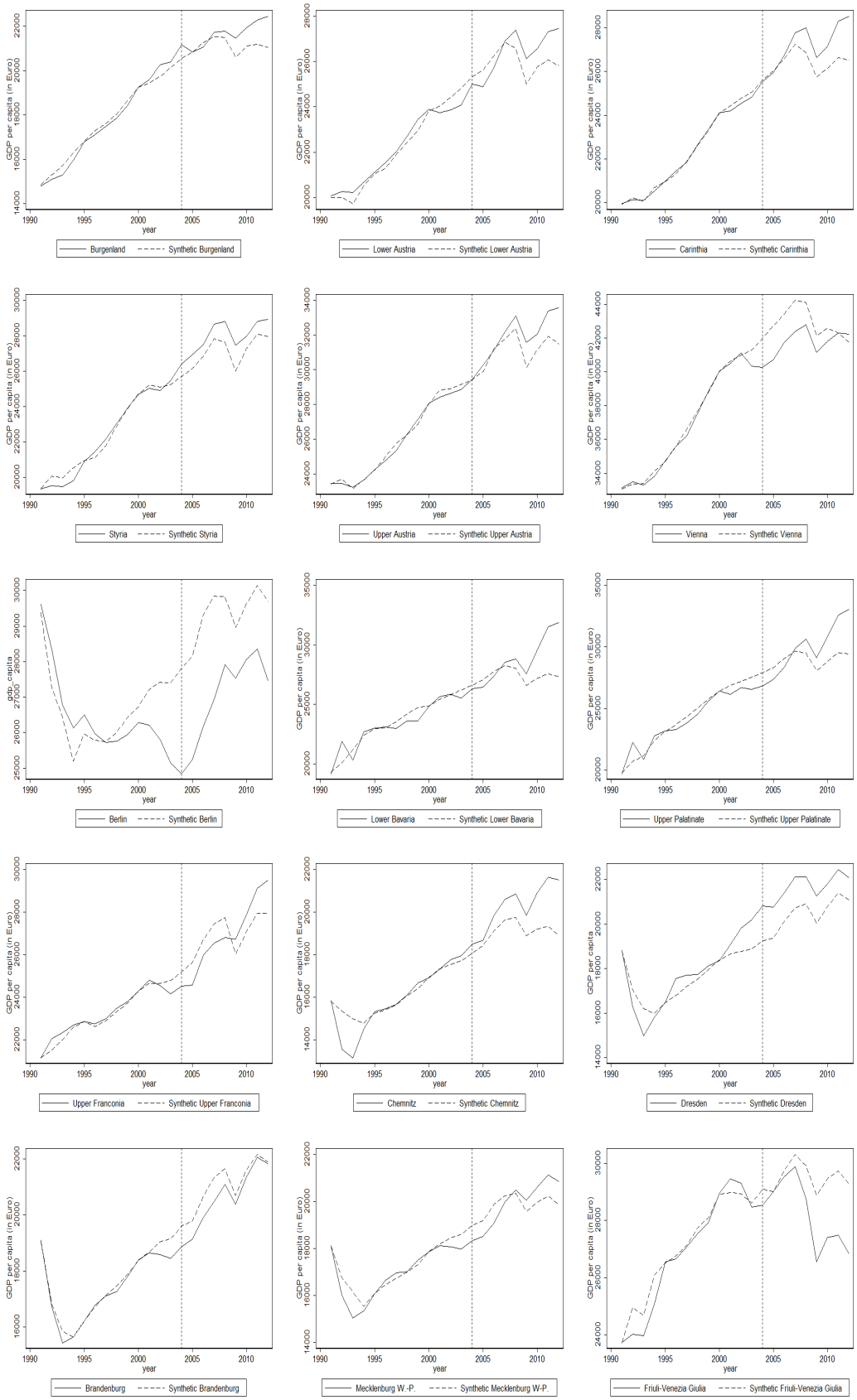


Figure 2.4: Economic Performance of Border Regions and their Synthetic Controls 1991-2012

Turning to the group of rural, economically weaker border regions, including Burgenland in Austria and Brandenburg and Mecklenburg-Western Pomerania in Germany, the graphs in Figure 2.4 show that the two German regions actually develop less favorably than their corresponding synthetic controls, while the Austrian region of Burgenland reveals a more favorable development than its synthetic control. In the two East German border regions of Brandenburg and Mecklenburg-Western Pomerania, the discrepancy in the two series already emerges in the years prior to the enlargement. As the values in Table 2.4 show, in both regions, the negative effects are actually larger in the short term. In the medium term, both border regions seem to catch up with their synthetic controls. Overall, these results only partly support the presumption that rural, economically weaker border regions could not capitalize on the EU Eastern enlargement to the same extent that economically stronger regions do (see, for example, Krätke and Borst, 2007; Petrakos and Topaloglou, 2008). As Table 2.5 shows, in none of these regions is the difference between the two series prior to and after the enlargement statistically significant, however.

When looking at the enlargement effects in the two capital cities and in the urban regions, results are surprisingly different. As the graphs in Figure 2.4 reveal, the capital cities Berlin and Vienna both reveal large negative effects. Hence, in Berlin, the difference between the actual GDP and the corresponding synthetic control amounts to -9.30% in the short term and to -7.60% in the medium term. For Vienna, the difference in the short term amounts to -3.94% and to -2.35% in the medium term (see Table 2.4). One possible explanation for the large negative effects may be the peculiarity of these capital regions, whose economic development may be primarily driven by the global economy and may not be affected by changes in market access at the regional level to the same extent that border regions with fewer ties to the global economy are. Moreover, the peculiarity of these regions in terms of population density aggravates the selection of suitable regions for the synthetic control. As Table I.20 in Appendix I shows, the synthetic control of Berlin only consists of four non-border regions, namely of Brussels, Leipzig, the French region Alps-French Riviera and the British region North Eastern Scotland. Hence, the negative enlargement effect for Berlin may be driven by the distinct economic performance of these four control regions in the 2000s. Effects are also negative in the Italian region of Friuli-Venezia Giulia and in the German region of Upper Franconia, suggesting

that economically successful urban regions do not profit from changes in market access as expected from the literature (Campos *et al.*, 2014; Krätke and Borst, 2007; Rodríguez-Pose, 2012). In the case of Friuli-Venezia Giulia, the negative effect may be attributed to country-specific effects. Hence, during the 2000s, the Italian economy developed less favorable than other large EU-15 economies such as the French or Spanish economy (Eurostat, 2016). When looking at the statistical significance of the effects, the discrepancy between the two series prior to and after the EU enlargement of 2004 is statistically significant in Berlin, whereas for the remaining regions, effects are not statistically significant (see Table 2.5).

In contrast, for the economically weaker urban border regions in the East of Germany, namely Chemnitz and Dresden, a positive enlargement effect can be observed (see Figure 2.4 and Table 2.4). However, as both regions received large amounts of public funds during the 2000s, the positive and statistically significant enlargement effects in these regions cannot be isolated from potential funding effects. Hence, both regions qualified as Objective 1 regions in the EU structural funding programming period 2000 to 2006 and in the programming period 2007 to 2013. Moreover, the German Federal State funds East German regions under the GRW program (Gemeinschaftsaufgabe - Verbesserung der Regionalen Wirtschaftsstruktur) (European Commission, 2015; Bundesministerium für Wirtschaft und Energie, 2016a and 2016b). Furthermore, the synthetic controls of both regions suffer from the relatively small number of non-border regions included. In the case of Chemnitz, only five non-border regions match the region's economic trajectory, indicating a certain degree of uncertainty about the ability of the synthetic control to reproduce the counterfactual situation, i.e. the economic development of the border regions had the EU Eastern enlargement not taken place.

Despite these caveats, the results still reveal several interesting findings. In particular, they show that border regions in the old member states have been differently affected by the EU Eastern enlargement of 2004. While all regions have continued their positive growth path after the EU Eastern enlargement, not in every region has the economic performance exceeded the economic performance of the counterfactual, i.e. the situation had the EU Eastern enlargement not taken place. On the aggregate level, results show that in contrast to popular concerns, the enlargement did not comprehensively weaken the economic performance of border regions. However, the enlargement did not lead to

a comprehensive strengthening of border regions either, as may have been assumed from economic theory (see Brülhart, 2011 and Niebuhr ans Stiller, 2002 for an overview). At least in the course of the EU Eastern enlargement of 2004, on average, the GDP of border regions has not been affected by the enlargement in a statistically significant way.

2.5.3 Explanatory Factors for Heterogeneous Treatment Effects

The results outlined above suggest that regions respond differently to the changes in market access. This section aims to shed more light on possible reasons behind the differential payoff of the EU Eastern enlargement 2004 for border regions. It does so by quantitatively examining factors that are associated with positive or negative enlargement effects. To identify regional factors that may drive the enlargement payoffs in border regions, a simple linear panel regression model with region and year fixed effects is estimated for the set of border regions in the post-enlargement period, i.e. from 2005 to 2012. Following the suggestions by Campos *et al.* (2014), the percentage difference between the actual GDP per capita of the border regions and their estimated synthetic counterparts serves as the dependent variable. This outcome variable inevitably suffers from being an estimate itself. Yet it is the best proxy for the extent to which a region has actually been affected by the EU Eastern enlargement. Formally, the regression model can be presented as follows:

$$Y_{jt} = \beta_0 + \beta_k \mathbf{X}_{k,jt} + \gamma_{j-1} R_{j-1} + \sigma_{t-1} T_{t-1} + \mu_{jt},$$

where Y_{jt} is the percentage difference between the actual and synthetic time series for region j at time t, β_0 is the unknown intercept, $\mathbf{X}_{k,jt}$ is a matrix of k observed explanatory variables, β_k is the corresponding coefficient for the $k-th$ variables, R_{j-1} are $j-1$ dummy variables for the border regions, γ_{j-1} are the coefficients for the region dummies, T_{t-1} are $t-1$ dummy variables for the years in the post-enlargement period, σ_{t-1} are the coefficients for the time dummies, and μ_{jt} is the error term.

Overall, four sets of potential explanatory factors for the differential enlargement payoffs across regions are examined. The first set includes again the regional factor allocation, approximated by the regional population density and the regional employment rate. Both

factors take up the assumption that regions with a larger endowment with human resources are better equipped to exploit the effects of economic integration. The second set includes the share of the industrial sector in the regional Gross Value Added (GVA). This factor responds to the assumptions of international trade theory based on Balassa (1965), suggesting that the sectoral composition of a region is an important aspect for the extent to which a region can benefit from economic integration. The third set reflects the regional knowledge base, measured by the regional share of human resources in science and technology and the regional patent intensity. It accounts for the fact that more innovative regions can better absorb new ideas (see, for example, Caragliu and Nijkamp, 2012). Furthermore, they may be more successful in fighting increased competition from foreign firms. The fourth set of factors includes the regional endowment with infrastructure, responding to the fact that infrastructure is important for cross-border economic activities (Thissen, 2005; Bröcker *et al.*, 2010). Data on all explanatory variables are again obtained from the Cambridge Econometrics Regional Database (2015) and the Eurostat Regional Database (2016).

Table 2.6 depicts the regression coefficients for four different estimated model specifications. As becomes evident from the reported estimates, the regional employment rate, the relative strength of the regional industrial sector and the regional endowment with physical infrastructure correlate statistically significantly with higher positive enlargement effects. In contrast, the regional population density and the regional innovativeness do not correlate with the magnitude of the enlargement payoff in a statistically significant way. While the results only consider selected region-specific factors and are not conclusive, they nevertheless provide initial insights on factors that possibly influence the extent to which border regions have profited from changes in market access following the EU Eastern enlargement of 2004.

Table 2.6: Explanatory Factors of the Enlargement Payoff in Border Regions[a]

	Specification 1	Specification 2	Specification 3	Specification 4
Employment Rate	72.74***	33.82**	33.96**	35.30**
	(15.21)	(13.23)	(13.75)	(13.48)
Population Density	-.008	-.014	-.015	-.017
	(.011)	(.009)	(.010)	(.010)
Strength Industrial Sector		.003***	.003***	.003***
		(.001)	(.001)	(.001)
Patent Intensity			-.209	-.644
			(4.12)	(4.09)
Human Resources in Science and Technology			-.076	-.143
			(.123)	(.124)
Roads				.363**
				(.162)
Constant	-60.30***	-46.54***	-41.95***	-50.93***
	(15.78)	(12.74)	(14.58)	(14.83)
Region FE	√	√	√	√
Year FE	√	√	√	√
Observations	120	120	120	120
R^2	.56	.72	.72	.74

[a] Table entries denote regression coefficients of with region and year fixed-effects. Standard errors in parentheses. Dependent variable: Percentage difference between the actual and the synthetic series of per capita GDP for each border region and each year after the EU Eastern enlargement 2004. Inference: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

2.6 Discussion and Conclusion

This essay has examined the effect of the EU Eastern enlargement in 2004 on the regional GDP per capita of German, Austrian and Italian regions located on the border to the new member states. It has done so by applying the Synthetic Control Method (SCM) that compares the economic performance of these border regions after the enlargement with a weighted combination of non-border regions that form the synthetically generated controls. This method allows the identification and evaluation of the economic enlargement effect in a causal way. Results show that on average, i.e. when considering all border regions together, a negative enlargement effect can be observed. This effect is mainly driven by the two capital cities of Berlin and Vienna. When excluding these two regions, a positive enlargement effect is visible in the medium term, suggesting that in line with regional economic theories, border regions are not the losers of the enlargement. Instead, they can indeed capitalize on their geographic location and profit from economic integration. This average enlargement effect is, however, not statistically significant.

When looking at the enlargement effects in the individual border regions, however, it becomes evident that border regions are differently affected by the changes in the market access. Descriptive evidence suggests that Austrian rural border regions with a high regional GDP per capita in the years prior to the enlargement have profited from the enlargement, while German rural regions with a lower GDP per capita prior to the enlargement could not capitalize on changes in market access to the same extent. For urban border regions, the opposite seems to be the case. Here, urban regions characterized by a lower GDP in the years prior to the enlargement have experienced positive enlargement effects, while urban regions with high GDPs per capita in the years prior to the enlargement have witnessed negative enlargement effects. However, these results may be driven by regional peculiarities of the two capital regions Berlin and Vienna, by possible intervening effects of public funds, and by country effects.

When quantitatively examining possible factors that may explain the heterogeneous enlargement payoffs across border regions, results show that the regional employment rate, the relative strength of the regional industrial sector and the regional endowment with physical infrastructure correlate statistically significantly with higher positive enlargement effects, while the regional innovativeness and population density do not correlate with the magnitude of the enlargement effect in a statistically significant way. This suggests that it is particular structural factors that matter. At the same time, the regions' endowment with physical infrastructure, which is a common target of regional growth programs (see Crescenzi and Rodríguez-Pose, 2012 for an overview), seem to be equally important.

Even though the results provide new insights into the effect of the EU Eastern enlargement on the economic performance of regions located on the former EU external border, some caveats have to be noted: firstly, the Stable Unit Treatment Value Assumption (SUTVA) may not hold in the context of the EU Eastern enlargement. Hence, changes in market access inevitably affected all European regions, not only border regions. The results can thus only be interpreted as lower bonds for the true effects. Secondly, in several border regions, the synthetic controls do not perfectly match the economic trajectory of the border region in the years prior to the enlargement. This may violate the assumption that border regions and their synthetic controls reveal similar growth paths in the years prior to the EU Eastern enlargement. To attenuate these mismatches, it would be desirable

to adjust the set of pre-enlargement GDP predictor variables to reflect better the growth trajectories of border regions in the pre-enlargement period. Yet the adjustment of the pre-enlargement GDP predictor variables is limited by the incompleteness of time-series data for many economic growth factors throughout the 1990s. The limited availability of data also prohibits the analysis at lower spatial levels such as the NUTS-3 or municipal level. Conducting empirical analyses at these lower levels would be desirable, as several empirical studies have shown that border effects rapidly decay with distance (Redding and Sturm, 2008; Brülhart *et al.*, 2012). In future research, it would also be desirable to repeat the analysis for alternative outcome variables such as the regional economic growth rate, the regional employment rate, or the regional wage structure. This would provide a more comprehensive picture on the economic effect of the EU Eastern enlargement in 2004 on border regions in the old member states. In order to confirm the robustness of the results, it would also be desirable to perform in-time and in-space placebos tests (for further discussion on the inference in the SCM, see Abadie *et al.*, 2010 and 2015).

Despite these caveats, the essay still provides an initial attempt to identify and evaluate the effects of the EU Eastern enlargement on the GDP of border regions in a causal way. Results show that in contrast to public concerns, on average, border regions in the old member states have not been the losers of the EU Eastern enlargement of 2004. Instead, many border regions have developed more favorably than they would have had the enlargement not taken place. For some border regions, however, negative effects can be observed. These heterogeneous effects suggest that the border location is not sufficient for regions to profit from changes in market access. Instead, the regional context of border regions matters. When translating the findings into the political contexts, they suggest that one-size-fits-all regional integration policies are not appropriate. Instead, results suggest that – in line with the Smart Specialization Strategy of European Commission (see, for example, McCann and Ortega-Argilés, 2015) – regional policies designed to accompany economic integration in border regions should pursue place-based solutions that consider regional characteristics.

Chapter 3

Do Open Borders Tempt a Saint? Evidence from the Schengen Acquis on Crime Rates in German Border Regions

The abolishment of passport and any other type of border controls at the German-Polish and German-Czech border in December 2007 provoked public concerns that open borders would increase cross-border crime. Despite these widespread concerns, empirical research on whether public fears are justified is still scarce. Based on official data on reported crimes from the German Police Crime Statistics, this essay evaluates whether the implementation of the Schengen Acquis in Poland and in the Czech Republic in December 2007 increased crime rates in German counties (Landkreise) that share a border with one of these two countries. Conditional difference-in-difference estimation allows the evaluation of the Schengen effect in a causal way. Results show that only for burglaries can a significant positive effect be observed. This suggests that for this type of criminal offense, public concerns proved to be justified. In contrast, for overall crime rates as well as for other common types of crime against poverty no significant effect can be observed, indicating that there is only little empirical evidence for the widespread concerns about public security.

Keywords: Crime Rates, Border Regions, Schengen Acquis, Open Borders

JEL Classification: R10, K40, F60, J60

3.1 Introduction

In December 2007, Poland and the Czech Republic as well as six other Eastern European countries joined the Schengen Zone, resulting in the abolishment of passport and any other type of border controls at the German-Polish and German-Czech border. While the enlargement of the Schengen Zone increased international cooperation and the speed with which goods and people traveled between the member states, the prospect of eliminating border controls also provoked public concerns that open borders would increase crime rates (see, for example, Killias, 1993; Schwell, 2009). In Germany, media coverage suggests that public concerns were particularly strong in regions bordering Poland and the Czech Republic, fueled by the perception that the geographic location directly on the border to Poland and the Czech Republic made these border regions particularly vulnerable to crime (see, for example, Rother, 2007; Weber, 2007). Border regions in the East German Federal States of Brandenburg and Saxony in particular still witness comparatively high voting shares for Euroskeptic, populist parties such as the AfD (Alternative for Germany) (Land Brandenburg, 2014) and the presence of vigilante groups in several border communities (Bangel, 2014; Bederke, 2014). These phenomena may be nourished by the image of the East as untrustworthy and threatening, which is rooted firmly in the collective memory of the Western public (Schwell, 2009; Schwell, 2015).

Based on official data of reported crimes of the German Police Crime Statistics on the county level (Landkreis), this essay examines whether the abolishment of border controls between Germany and Poland and Germany and the Czech Republic in December 2007 affected crime rates in German regions bordering one of these two countries. Effects are identified by conditional difference-in-difference estimations that allow the evaluation of the Schengen effects in a causal way. By applying a quasi-experimental research design that compares the development of crime rates in border regions with the approximated counterfactual situation, i.e. the development of crime rates in these regions had the Schengen Acquis not taken place, the essay exceeds official reports of the German Ministry of the Interior (Bundesministerium des Inneren, 2010a) or the European Commission (European Commission, 2012), which are merely based on descriptive evidence.

The empirical results depict no significant increase in overall crime rates in border regions, following the Schengen Acquis. For burglaries, however, the empirical analysis reveals a

statistically significant increase. This suggests that for burglaries, public concerns proved to be true and public authorities would do well to counteract criminal activities in border regions. At the same time, the empirical findings show that for other, more common types of criminal offenses, including thievery from motor vehicles, drug-related crimes, or street crime, the abolishment of border controls revealed virtually no effect on crime rates. In light of the current discussion on the future of the Schengen Zone and borderless Europe, this is an important result, because it shows that at least for border regions on the German-Polish and German-Czech border, there is only little empirical support for the widespread concerns about public security.

The remainder of the essay is structured as follows: Section 3.2 identifies the mechanisms through which the abolishment of border controls may affect crime rates in border regions and discusses the related literature. Section 3.3 describes the empirical strategy, while Section 3.4 reports the empirical results. Finally, Section 3.5 concludes.

3.2 Theory and Related Literature

3.2.1 Regional Crime Rates

The theoretical starting point in this essay is the standard rational choice model of crime participation introduced by Becker (1968) and revised by Ehrlich (1973).[1] According to the model, an individual will engage in crime if the returns from committing a crime outweigh the returns from non-criminal behavior. The returns from committing a crime are calculated relative to the probability of getting caught and the expected sanction if caught. Hence, an individual may commit a crime if:

$$(1-p)U(Crime) - pU(S) > U(Non\text{-}Crime),$$

whereby $U(Non\text{-}Crime)$ denotes the utility from abstaining from crime, $U(Crime)$ denotes the utility from a successful crime, i.e. a crime in which the perpetrator is not

[1] For a detailed discussion on the model at the regional level, see, for example, Soares (2004) or Entorf and Spengler (2000).

caught, p denotes the probability of being caught, and S the monetary-equivalent sanction if caught (Soares, 2004). Whether an individual will engage in criminal activities then depends on the anticipated costs and benefits of criminal behavior compared to legal behavior. Translated to the regional level, this means that the more prevalent the conditions which make crime attractive in a region, the higher the crime rates within a region are (Soares, 2004).

In the spirit of the Becker-Ehrlich model, the conditions that make crime more or less attractive within a region are frequently attributed to the level of deterrence and to the level of legal and illegal income opportunities within a region (see Entorf and Spengler, 2000 for the German context). The level of deterrence is commonly indicated by the regional clearance rate and the level of sanctions. Legal and illegal income opportunities can be approximated by several regional characteristics such as the regional income structure, the regional unemployment rate, or the regional GDP.

Deterrence variables such as the clearance rate within a region affect the probability of getting caught, p, and, consequently, the expected utility that potential offenders can yield from crime $U(Crime)$. A higher propensity of getting caught thereby reduces the expected utility from criminal activities. Similarly, higher levels of sanctions, S, such as higher prisoner rates or longer average sentences, decrease the utility that a potential offender can yield from committing a crime. Along with the regional level of deterrence, legal and illegal income opportunities also determine the attractiveness of criminal behavior within a region. Both affect the utility that motivated offenders may gain both from committing a crime $U(Crime)$ and from non-illegal behavior $U(Non\text{-}Crime)$. The legal and illegal income opportunities within a region can be approximated by economic variables such as the regional income level or the region's economic performance. The income level within a region can thereby serve as an indicator for both the presence of more or less rewarding jobs and, in turn, higher or lower legal income opportunities within a region. Similarly, it can serve as an indicator for higher or lower levels of transferable assets within regions, making these regions more or less lucrative targets for potential offenders (Entorf and Spengler, 2000). Further variables that are commonly identified in the literature as affecting a regions' susceptibility to crime include the regional unemployment and youth unemployment rate, the regional demographic structure, the share of foreigners and the regional level of educational attainment (see Entorf and Spengler, 2000

for the German context). Regional crime rates may thus be driven by two sets of factors: firstly factors that are associated with the level of deterrence, and secondly factors that are associated with legal and illegal income opportunities within a region. Motivated offenders should then choose committing a crime in region i rather than in region j when the difference between the utility of committing a crime relative to non-criminal behavior is larger in region i than it is in region j.

3.2.2 Removal of Border Controls and Crime Rates in Border Regions

When border controls are abolished, any change in crime rates in border regions could be attributed to either an increase in crimes committed by domestic offenders or to an increase in crimes committed by offenders from abroad that choose to commit a crime in border regions on the other side of the border rather than in their domestic region or rather than abstaining from criminal activities.

Regarding the first possibility, the abolishment of border controls between Germany and Poland and Germany and the Czech Republic should not affect the utility of domestic offenders, since for them, the probability of getting caught $(1 - p)$ and the level of sanctions S should not change when keeping all other factors constant. Furthermore, regional characteristics that affect legal and illegal income opportunities, such as regional employment rates or income levels, should remain stable in the short-term. Hence, for domestic offenders, the utility of committing a crime $U(Crime)$ and the utility form non-criminal behavior $U(Non\text{-}Crime)$ should, ceteris paribus, not be affected by the abolishment of border controls.

In contrast, for motivated offenders from the East, the abolishment of border controls between Germany and Poland and Germany and the Czech Republic may increase the utility of committing a crime in German border regions relative to the utility of committing a crime in domestic regions or the utility from non-criminal behavior. Hence, the removal of border controls may decrease the probability of getting caught p when committing a crime in German border regions. The relatively lower probability of getting caught is reinforced by the fact that cross-border law enforcement is still not fully implemented between Germany and Poland and Germany and the Czech Republic (Schwell,

2015). Motivated offenders from the East can thus expand their operation radius to Germany without facing a higher probability of getting caught. The geographic location of German border regions possibly makes these regions more attractive targets than other German regions, given the potentially lower transaction costs for offenders from the East. These may result from lower transportation costs and a higher familiarity of offenders with these geographically close border regions compared to more distant German regions (for a similar argument for the Swedish-Danish border, see Ceccato and Haining, 2004). The susceptibility of German border regions to crime may also be reinforced by the fact that – except for the northernmost part of the German-Polish border where the River Oder separates Germany from Poland – the border between both Germany and Poland and Germany and the Czech Republic is a land border. This type of border adjacency is commonly assumed to facilitate the movement of motivated offenders (see Ceccato and Haining, 2004).

When offenders from the East are no longer penalized by a higher probability of getting caught when committing a crime in German border regions, these regions may constitute more lucrative targets compared to Polish or Czech regions. This results from the large wealth differential between Germany and its Eastern neighbors. Hence, the Gross National Income (GNI) per capita, measured in purchasing power parties, of Poland and the Czech Republic amounted to merely 40% of that of Germany in 2006, i.e. a year before Poland and the Czech Republic implemented the Schengen Acquis (Baas and Brücker, 2010). German regions might thus be better endowed with transferable assets. At the same time, offenders from the East may face lower sanctions S when committing crimes in Germany than in Poland or the Czech Republic, given that the punitivity is higher in Poland and the Czech Republic than it is in Germany (Dünkel and Geng, 2013)[2]. This may further increase the utility for committing crimes in German border regions relative to committing a crime in domestic regions or relative to the utility for abstaining from criminal activities.

However, descriptive evidence presented in governmental reports (for example Bundesministerium des Inneren, 2010a) shows that criminal offenses in border regions did not in-

[2]Hence, the rate of prisoners, which is commonly used as an indicator for the punitivity within a country, is higher in Poland and the Czech Republic than it is in Germany. In 2012, for example, Poland had 220 prisoners per 100,000 inhabitants and the Czech Republic 219 prisoners per 100,000 inhabitants, whereas the rate of prisoners in Germany amounted to merely 83 prisoners per 100,000 inhabitants in the same year (Dünkel and Geng, 2013).

crease after Poland and the Czech Republic joined the Schengen Zone. One reason for the non effect could be that in anticipation of an increase in motivated offenders, Federal States along the border could have increased their police force to counteract criminal activities. This would increase the level of deterrence and affect the probability of getting caught $(1 - p)$ for both domestic and foreign offenders. Indeed, following the implementation of the Schengen Acquis in Poland and the Czech Republic, mobile identity checks in border regions on both sides of the border were expanded to compensate for direct border controls (Rother, 2007; Weber, 2007).

On the German side, the extra effort is depicted in an increase of expenditures to the Federal Border Police as well as an increase in expenditures to the police in the Federal States bordering Poland and the Czech Republic (see Figure 3.1).

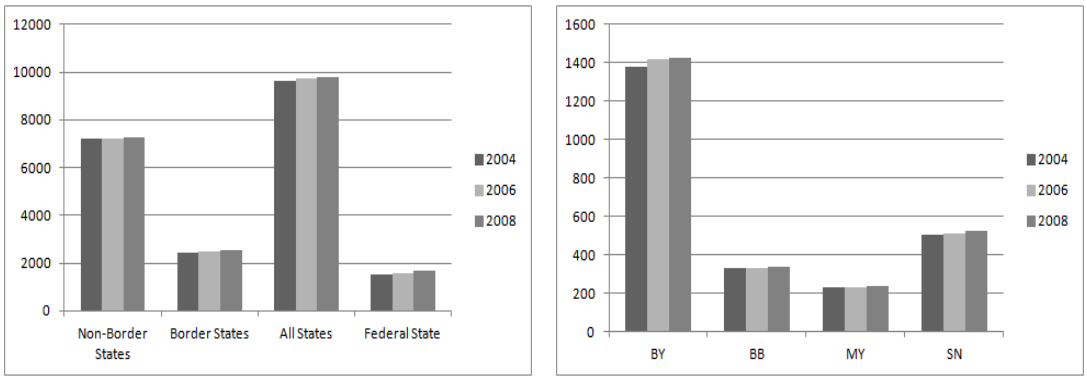


Figure 3.1: Police Expenditures 2004, 2006 and 2008
The left graphic depicts police expenditures in border states and non-border states as well as expenditures of the Federal States. The right graphic depicts expenditures by border state; BY=Bavaria; BB=Brandenburg; MV=Mecklenburg-Western Pomerania; SN=Saxony. Data are obtained from the Statistical Yearbooks of the German Federal Statistical Office (Statistisches Bundesamt, 2007, 2009 and 2011).

Expenditures increased relatively more in Federal States bordering Poland or the Czech Republic (3.6% between 2004 and 2008) than in non-border Federal States (0.7% between 2004 and 2008). At the federal level, expenditures even increased by 8.4% during the same period of time. Out of the Federal States on the border to Poland and the Czech Republic, Saxony revealed the largest increase in expenditures to the police between 2004 and 2008. Hence, in Saxony, expenditures increased by 4.7% between 2004 and 2008. In the same period, expenditures increased by 3.4% in Bavaria, by 3.0% in Mecklenburg-Western Pomerania and by 2.7% in Brandenburg. When looking at the clearance rates in border regions, Figure 3.2 shows that clearance rates actually decreased in all four Federal

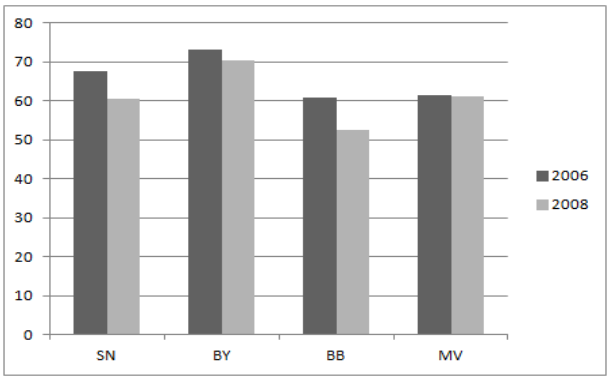


Figure 3.2: Clearance Rate in Border Regions by Federal State 2006 and 2008
Clearance rate (in %); BB=Brandenburg; BY=Bavaria; SN=Saxony; MV=Mecklenburg Western-Pommerania. Data are obtained from the German Police Statistics (Bundeskriminalamt, 2007 and 2009).

States that share a border with Poland or the Czech Republic between 2006 and 2008. This suggests that despite the extra effort in police expenditures, the level of deterrence decreased after the abolishment of border controls. This supports the argument that the probability of getting caught, p, decreased following the abolishment of border controls between Germany and its Eastern neighbors.

3.2.3 Related Empirical Studies

Even though the abolishment of border controls and its effect on public security is emotionally and controversially discussed in the public debate, empirical evidence on the effect of open borders on crime is scarce. One reason for the lack of empirical research is that in the last decade following 9/11, border controls worldwide were expanded, rather than relaxed (Schwell, 2015). Hence, the Schengen Zone constitutes an exceptional case in which physical barriers were actually removed. Yet most studies that examine the consequences of the Schengen enlargement focus on the economic effects of open borders. Davis and Gift (2014), for instance, find that the Schengen membership yields positive effects on trade, while Bartz and Fuchs-Schündeln (2012) show that the abolishment of border controls does not affect cross-border labor mobility in a statistically significant way. In contrast, the effects of the Schengen Acquis on crime are only rarely assessed.

The majority of studies, which focus on the effects of open border on crime, investigate the effects of increased migration. The main conclusion of these studies is that higher levels of immigrants in a given region significantly correlate with higher crime rates in crimes against poverty, i.e. burglary or thievery, but not with higher crime rates in crimes against the person, i.e. assaults or other forms of violent crimes (see, for example, Bell *et al.*, 2013 for Great Britain; Bianchi *et al.*, 2012 for Italy; and Alonso-Borrego *et al.*, 2012 for Spain). However, migration is only one possible phenomenon of open borders and cannot be attributed to the abolishment of border control alone. Moreover, the Federal States of Brandenburg, Saxony and Bavaria have not witnessed a significant increase in migration following the Schengen Acquis (Bundesministerium des Inneren, 2010b).

A further related stand of literature evaluates the effects of large infrastructure projects that facilitate cross-border movements of people and goods. Here, the study by Ceccato and Haining (2004) examines how the establishment of the Oresund Bridge affected crime rates in Swedish and Danish border regions. Their findings show that the bridge between Sweden and Denmark did not lead to higher crime rates in border regions in general. Only for vehicle-related crimes did the authors find a significant increase. Their findings correspond to a previous report released by the Swedish State Police that examined changes in local crime patterns after the establishment of the Eurotunnel connecting England and France (Ceccato and Haining, 2004). However, both studies focus on the effects of decreased cross-border transaction costs, but not on the genuine effect of abolishment of border control. This essay, in contrast, aims at identifying the impact of the removal of border controls themselves. The following sections set up the empirical strategy for identifying the Schengen effect, present the empirical results and discuss these results in the light of the current discussion on the future of the Schengen Zone.

3.3 Empirical Strategy

3.3.1 Crime Rates in German Border and Non-Border Regions

The empirical analysis aims at identifying the causal effect of the abolishment of border controls between Germany and its Eastern neighbors on crime rates in the German border regions. The removal of border controls came into force on 21 December 2007, when

Poland and the Czech Republic as well as six other Eastern European states implemented the Schengen Acquis. The empirical analysis is based on annual panel data of German counties (Landkreise) for the years 2004 to 2008. The lower bond 2004 is given by the accessibility of official crime data at the county level. The last year of the observation period, 2008, is also determined by the availability of data. Because regional borders in Saxony changed in the course of local governmental reorganization, it is not possible to compare crime data for years before 2009 and after 2009 in Saxon regions. Figure 3.3 maps the 31 German counties (Landkreise) that share a border with Poland or the Czech Republic. These regions constitute the treatment group in the subsequent analysis[3].

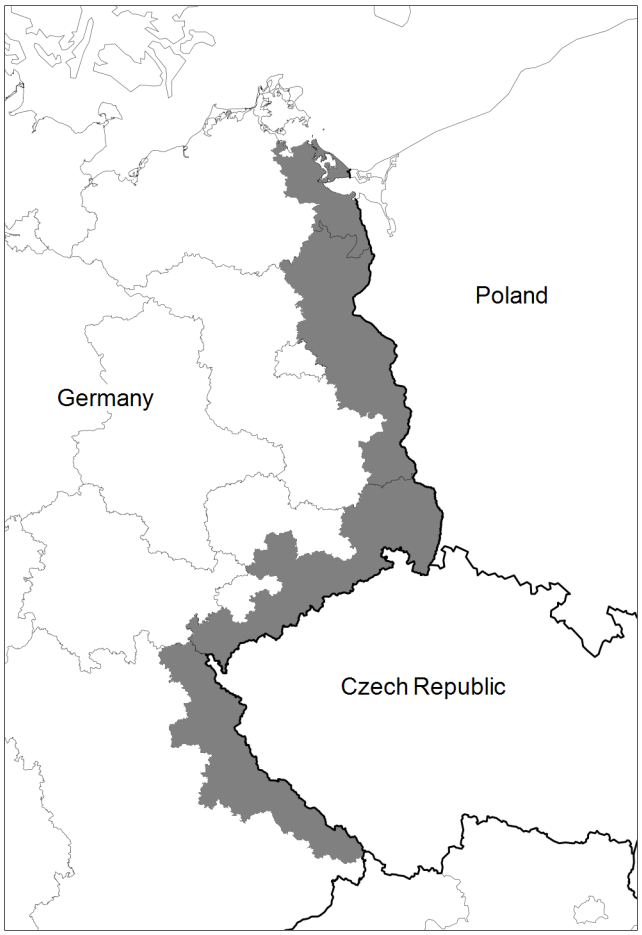


Figure 3.3: Map of German Border Regions
German counties (Landkreise) located at the border to Poland and the Czech Republic in grey coloring.

[3]The empirical analysis is based on the NUTS-3 classification for 2007, i.e. the year the Schengen Acquis was implemented in Poland and the Czech Republic. In Saxony-Anhalt, regional borders also changed during the observation period. However, in Saxony-Anhalt, crime rates for 2008 could be recalculated in accordance with the distribution of inhabitants for the years prior to the reform.

Data on regional crime rates, i.e. the annual number of reported crimes per 1,000 inhabitants, are compiled from the official German Police Crime Statistics (Polizeiliche Kriminalitätsstatistik) for the Federal Republic of Germany provided by the Federal Criminal Police Office (Bundeskriminalamt). The Police Crime Statistics are so-called outgoing statistics. This means that the statistics contain only those offenses which have come to the attention of the police and have been passed to the public prosecutor's office before compilation began (see Bundeskriminalamt, 2016 for detailed information on the data). The Police Crime Statistics thus do not contain undetected criminal offenses. Therefore, the data do not reveal the real number of crimes within a region, but only the number of recorded cases, which may differ across regions and across types of criminal offenses. Yet a recent study conducted at the German Institute of Economic Research (DIW) shows that in Germany regional crime patterns are – with some exceptions – comparable when including dark figures, i.e. underreported crimes (Bug *et al.,* 2015). Along with the overall regional crime rate, the regional crime rates for selected crimes against poverty are also examined. This accounts for the fact that crimes against poverty such as burglary, thievery, drug-related crimes, criminal mischief and street crime are mostly economically driven and should thus be particularly affected by the abolishment of border controls[4].

Figure 3.4 depicts crime rates of the counties (Landkreise) located on the border to Poland and the Czech Republic for the years 2006 and 2008, i.e. one year prior to and one year after the abolishment of border controls at the German-Polish and German-Czech border. As the graphics reveal, the overall number of criminal offenses in these regions amounted to 61 crimes per 1,000 inhabitants in 2006, and dropped slightly to 58 crimes per 1,000 inhabitants in 2008. Approximately one third of all crimes were crimes against poverty. When only considering these types of crimes, the rate increased from 22 crimes per 1,000 inhabitants in 2006 to 24 crimes per 1,000 inhabitants in 2008 in border regions. As Figure 3.4 reveals, this increase is mainly driven by a rise in street crimes and criminal mischief, which are the most common types of crimes against poverty. The rate of burglary also marginally increased between 2006 and 2008, while the rate of both drug-related crimes and thievery from motor vehicles decreased in the border regions between 2006 and 2008.

[4]The five types of criminal offenses against poverty assessed in this essay (i.e. burglary, thievery from motor vehicles, criminal mischief, street crime and drug-related crimes) encompass all types of crimes against poverty for which data on the NUTS-3 level is available in the German Criminal Police Statistics.

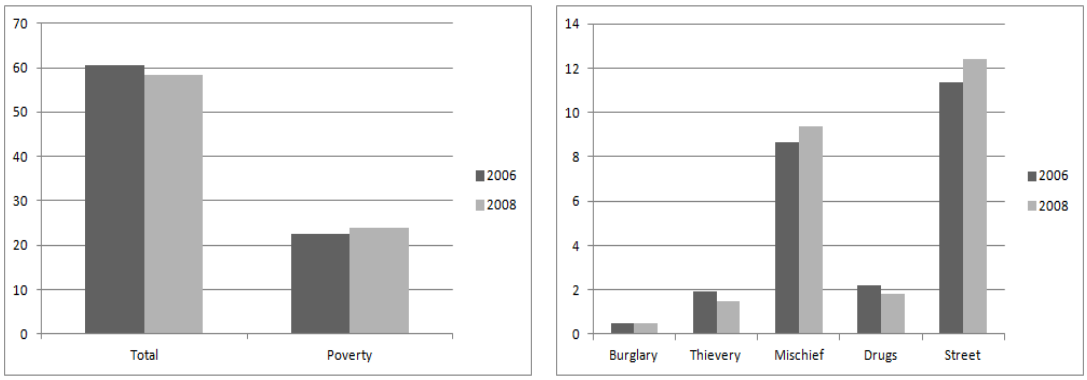


Figure 3.4: Crime Rates in German Border Regions 2006 and 2008
Crimes per 1,000 inhabitants in border regions. Data are obtained from the German Police Crime Statistics (Bundeskriminalamt, 2007 and 2009).

The descriptive evidence in Figures 3.4 shows that overall, there is no noticeable increase in criminal offenses in border regions between 2006 and 2008, i.e. the years prior to and following the Schengen Acquis in Poland and the Czech Republic. Yet the description only reveals the naive effect, i.e. the difference between crimes in border regions before and after the abolishment of border controls[5]. This effect, however, does not say anything about how the rate of criminal offenses in border regions would have developed had Poland and the Czech Republic not joined the Schengen Zone.

To identify the causal effect of the Schengen Acquis on border regions one would have to compare the crime rates in border regions in the period after the abolishment of border controls, i.e. $E(y_t|D = 1)$ with crime rates in border regions in the same period had the Schengen enlargement not taken place, i.e. $E(y_t|D = 0)$. However, the situation $E(y_t|D = 0)$, i.e. crime rates in border regions in the period after the abolishment of border controls had Poland and the Czech Republic not joined the Schengen Zone, is unobservable. This is what Holland (1986) calls the fundamental problem of causal inference. One strategy to overcome the problem of causal inference is to approximate the counterfactual situation by identifying a suitable control group of non-treated units, i.e. non-border regions, that are sufficiently similar to the treated ones, i.e. border regions. One possible control group for the German regions located on the border to Poland and the Czech Republic are all German regions that are not located on the border to these

[5]The naive estimator is commonly given as $\delta = E(y_t|D = 1) - E(y_{t-1}|D = 0)$, whereby y_t is the outcome (crime rate) in border regions in the post-Schengen period t in the presence of the Schengen Acquis, D=1, and y_{t-1} is the outcome (crime rate) in border regions in the pre-Schengen period $t-1$ in the absence of the Schengen Acquis, D=0 (see, for example, Shadish *et al.*, 2002).

two countries. Since the selection of border regions in the treatment group is exogenously given by the geographic location of a region and is stable over time, this may be a reasonable approach.

However, the simple comparison between crime rates of border and non-border regions before and after the implementation of the Schengen Acquis in Poland and the Czech Republic may not be suitable, as border regions may systematically differ from non-border regions in a number of regional characteristics that may be related to regional crime rates. The population density in these predominantly rural border regions, for instance, may be below the German average. At the same time, border regions may witness comparatively high unemployment rates, given that the majority of border regions are located in the East German Federal States with unemployment rates above the German average (Eurostat, 2016). These discrepancies may violate the conditional independence assumption, stating that – when controlling for certain region-specific covariates $\mathbf{X}$ – crime rates y in the pre-Schengen period $t-1$ and post-Schengen period t are independent from the border location B, i.e. $E(y) \perp B|\mathbf{X}$. This implies that $E(y_{t-1}|B=1,\mathbf{X}) = E(y_{t-1}|B=0,\mathbf{X})$ and $E(y_t|B=1,\mathbf{X}) = E(y_t|B=0,\mathbf{X})$. The factors that may influence crime rates should thus develop similarly in border and non-border regions. When the conditional independence assumption is violated, these factors – and consequently crime rates – in border and non-border regions would develop differently, even if Poland and the Czech Republic had not implemented the Schengen Acquis. Hence, it may not be a good idea to use the mean of all non-border regions as the control to approximate the counterfactual situation.

Indeed, the values depicted in Table 3.1 show that German NUTS-3 regions located on the border to Poland and the Czech Republic differ from the average German non-border region in several factors that potentially influence regional crime rates such as the regional demography, the regional economic performance, the regional education level and regional clearance rates. Hence, the t-test for the mean comparisons suggests that border and non-border regions substantially differ in almost all region-specific characteristics under consideration. The statistically significant mean differences in the majority of regional characteristics indicate that the conditional independence assumption may be violated and that crime rates in border and non-border regions develop differently even in the absence of the Schengen Acquis.

Table 3.1: Descriptive Statistics of Border Regions and Non-Border Regions[a]

	Border Regions	Non-Border Regions	t	$p > \|t\|$
Share < 6 Years of Age	4.59	5.28	10.97	0.000***
Share 6 < 18 Years of Age	11.21	12.67	8.12	0.000***
Share 18 < 25 Years of Age	8.82	8.28	-5.44	0.000***
Share 25 < 30 Years of Age	5.35	5.61	3.00	0.000***
Share 30 < 50 Years of Age	29.46	30.42	7.24	0.000***
Share 50 < 65 Years of Age	19.70	18.50	-9.47	0.000***
Share 65 < 75 Years of Age	12.22	11.02	-10.1733	0.000***
Share > 75 Years of Age	8.65	8.22	-3.99	0.001**
Population Density	233.15	237.01	4.976	0.000***
Share of Foreigners	3.05	7.34	10.17	0.000***
Umemployment Rate	16.37	10.70	-12.36	0.000***
Youth Unemployment	12.50	12.80	1.50	0.134
Income per capita	14,932.57	17,264.21	11.32	0.000***
GDP per capita	20,083.95	25,658.90	5.9816	0.000***
Share Unskilled Labor	13.27	16.17	7.49	0.000***
Share University Degree	8.12	8.35	0.66	0.509
Clearance Rate	66.14	58.27	-11.03	0.000***

[a] Column (1) reports means for the years before the Schengen Acquis (2004-2006) in border regions (N=124); column (2) reports means for the years before the Schengen Acquis (2004-2006) in non-border regions (N=1,592). Column (3) reports the t-values of the test on the H_0 that the mean value of each variable is the same in the treatment and control group. Column (4) shows that the H_0 can be rejected for almost all covariates. Stars denote significance as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Indeed, Figure 3.5 shows that while border and non-border regions share a common trend in overall crime rates, the development of crime rates in crimes against poverty differs between border and non-border regions in the years prior to the Schengen Acquis. Since the common trend assumption is violated, a simple comparison between border and non-border regions may not be suitable; instead it appears crucial to identify a more credible control group.

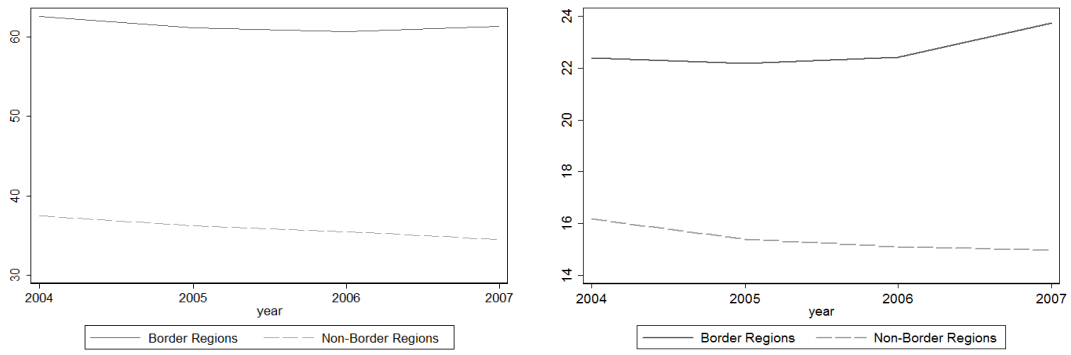


Figure 3.5: Crime Rates in German Border and Non-Border Regions 2004-2007
The left graph depicts the development of crime rates in overall crimes in the pre-Schengen period; the right graph depicts the development of crime rates in crimes against poverty in the pre-Schengen period. Data are obtained from the German Police Statistics (Bundeskriminalamt, 2005 to 2008).

3.3.2 Matching Treatment and Control Regions

To identify a control group that better approximates the counterfactual situation, i.e. the development of crime rates in border regions in the absence of the abolishment of border controls, statistical matching is used. Statistical matching aims at controlling preexisting differences between the treatment and control group, so that units in the treatment group are similar or only randomly different from the units in the matched control group on all observed covariates $\mathbf{X}$ that may affect the outcome variable (Stuart and Rubin, 2008). In doing so, it satisfies the conditional independence assumption that requires that the border location B is not related to crime rates prior to the abolishment of border controls, when controlling for region-specific factors $\mathbf{X}$. Hence, any difference in $\mathbf{X}$ that is due to the border location B is ruled out. Consequently, crime rates are then independent from the border location given, i.e. $E(y) \perp B|\mathbf{X}$ (see Stuart and Rubin, 2008).

As the matching procedure, one-to-one nearest-neighbor propensity score matching without replacement is applied. Hence, each border region is matched to the non-border region (without replacement) that has a similar probability, i.e. propensity, of receiving the treatment, given the set of observed covariates $\mathbf{X}$ (see Rosenbaum and Rubin, 1983 or Stuart and Rubin, 2008 for details). Propensity score matching is chosen as the number of covariates that can impact regional crime rates is quite high and propensity score matching decreases the dimensionality of the set of potential covariates $\mathbf{X}$ on which border and non-border regions are matched (Rosenbaum and Rubin, 1983). To satisfy the common support assumption, requiring that $0 < Prob(B = 1|\mathbf{X} = 1) < 1$ over the distribution of $\mathbf{X}$, only border regions and their matched controls that are on common support are included in the empirical analysis (Stuart and Rubin, 2008)[6].

The set of covariates $\mathbf{X}$, which are used to estimate the propensity scores of the regions, contains several regional characteristics that are assumed to affect criminal activities within a region (see Section 3.2). Precisely, the set includes the regional demographic composition, the regional economic performance, the regional level of educational attainment and the regional clearance rate. Data for the covariates are obtained from Eurostat (2016), the Cambridge Econometric Regional Database (2015), the INKAR data of the

[6]Four border regions, namely Freyung-Grafenau and Wunsiedel in Bavaria and Görlitz and Niederschlesischer Oberlausitzkreis in Saxony are not on common support and are therefore excluded from the analysis. This alters the average means of border regions between Table 3.1 and Table 3.2.

German Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR, 2016) and the German Police Crime Statistics released by the Federal Criminal Police Office (Bundeskriminalamt, 2005 to 2009). The propensity score is calculated by a logistic regression model that regresses the binary border variable on a set of regional control variables in 2006, i.e. the year prior to the implementation of the Schengen Acquis in Poland and the Czech Republic. The estimated coefficients for the likelihood of being a border region, i.e. treatment region, that is $P(B|X)$, are displayed in Table I.31 in Appendix Part I.

The final sample consists of 27 region pairs. Table I.32 in Appendix Part I lists the 27 border regions and their matched control regions. The list shows that most matched control regions are regions within the same Federal State. Out of the matched control regions, merely three regions (namely Demmin, Zwickauer Land and Hoyerswerda) are direct neighbors of border regions. Direct spatial spillover effects, should hence not greatly affect the results.

Table 3.2: Descriptive Statistics of Border Regions and Matched Control Regions[a]

	Border Regions	Matched Control Regions	t	$p > \|t\|$
Share < 6 Years of Age	4.58	4.54	-0.403	0.687
Share 6 < 18 Years of Age	11.15	10.86	-1.1270	0.261
Share 18 < 25 Years of Age	8.88	9.17	2.11	0.036**
Share 25 < 30 Years of Age	5.40	5.59	1.716	0.088*
Share 30 < 50 Years of Age	29.53	29.76	1.12	0.266
Share 50 < 65 Years of Age	19.74	19.72	-0.08	0.935
Share 65 < 75 Years of Age	12.18	12.04	-0.73	0.467
Share > 75 Years of Age	8.56	8.32	-1.451	0.148
Population Density	224.83	227.31	0.36	0.716
Share of Foreigners	3.01	2.99	-0.077	0.937
Umemployment Rate	16.34	16.41	0.097	0.923
Youth Unemployment	12.51	12.77	0.836	0.404
Income per capita	14,936.23	14,736.75	-1.087	0.278
GDP per capita	20,219.78	20,641.52	0.42	0.676
Share Unskilled Labor	12.70	12.21	-0.80	0.427
Share University Degree	8.26	9.62	2.37	0.019**
Clearance Rate	64.75	62.98	-2.14	0.033**

[a] Column (1) reports means for the years before the Schengen Acquis (2004-2006) in border regions (N=108); column (2) reports means for the years before the Schengen Acquis (2004-2006) in matched non-border regions (N=108). Column (3) reports the t-values of the test on H_0 that the mean value of each variable is the same in the treatment and control group. Column (4) shows that the H_0 cannot be rejected for almost all covariates. Stars denote significance as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3.2 shows that the matching procedure generates a balanced sample of treated regions, i.e. border regions, and control regions, i.e. non-border regions, in terms of observed characteristics. Hence, the t-tests of the difference in variable means between treatment

and control group show insignificant results in all cases, indicating that the matching procedure indeed eliminates observable differences between treatment and control groups in key regional characteristics. The balance between treatment and control groups on the observed covariates suggests that the two groups will only randomly differ on all observable and unobservable background covariates (see Stuart and Rubin, 2008).

Moreover, Figure 3.6 shows that crime rates in border regions and their matched controls follow a common trend in the pre-treatment period, which satisfies the common trend assumption. Since crime data at the county level are not publicly available before 2004, a more thorough test of the common trend assumption is not possible. To be precise, it is neither possible to conduct long pre-treatment trend comparisons nor to conduct any pseudo-treatment test. However, as the graphs in Figure 3.6 depict, aggregated crime rates in border regions for the period from 2004 to 2007 and their matched controls are sufficiently similar. Controlling for several regional characteristics that potentially affect regional crime rates should further alleviate concerns regarding the validity of the common trend assumption (for similar empirical strategies, see, for example, Braakmann and Vogel, 2010 or Gathmann *et al.*, 2014).

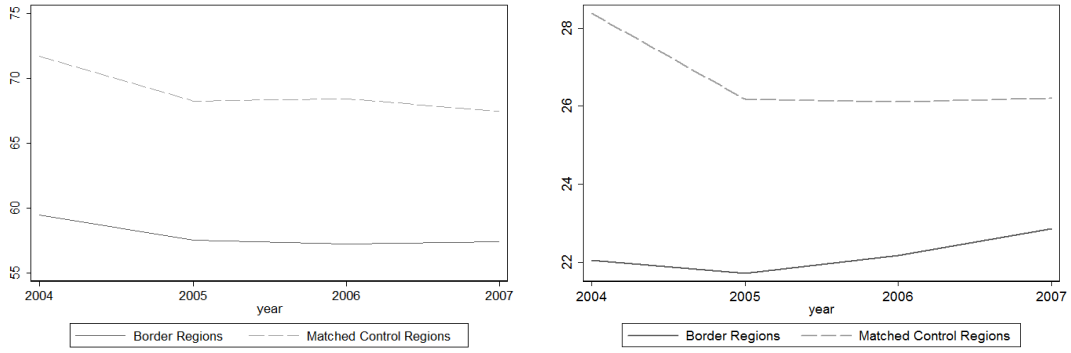


Figure 3.6: Crime Rates in German Border Regions and Matched Control Regions 2004-2007
The left graph depicts crime rates in overall crimes in the pre-Schengen period; the right graph depicts crime rates in crimes against poverty in the pre-Schengen period. Data are obtained from the German Police Statistics (Bundeskriminalamt, 2005 to 2008).

3.3.3 Estimating the Schengen Effect

Having identified a suitable control group, the Schengen effect on crime rates in border regions, i.e. the Average Treatment effect on the Treated (ATT), can be defined as the

difference of the difference in crime rates prior to and after the Schengen Acquis between border and non-border regions, i.e.

$$\delta = [E(y_t - y_{1t-1}|B = 1) - E(y_t - y_{t-1}|B = 0)],$$

whereby $E(y_t - y_{1t-1}|B = 1)$ is the difference in crime rates prior to and after the Schengen Acquis in border regions and $E(y_t - y_{1t-1}|B = 0)$ the difference in non-border regions. This equation is also referred to as the conditional difference-in-difference (DiD) estimator (see Blundell and Costa-Dias, 2000 or Smith and Todd, 2005 for a detailed discussion). The corresponding linear difference-in-difference regression model estimated based on annual panel data for border regions and their matched control regions for the years 2004 to 2008 can be formalized as:

$$y_{it} = \alpha_i + \beta_1 B_i + \beta_2 T_{it} + \beta_3 (B_i T_{it}) + \beta_4 \mathbf{X}_{it} + \epsilon_{it},$$

where y_{it} is the outcome of interest, i.e. the rate of criminal offenses of a certain type in region i at time t, α_i is the region-specific constant, B_i is a binary variable that takes the value 1 for border regions and 0 for non-border, β_1 captures the difference between border and non-border regions in the absence of the Schengen effect, T_{it} contains a time dummy for 2008, i.e. the year after the implementation of the Schengen Acquis in Poland and the Czech Republic, β_2 captures the corresponding coefficient, $\mathbf{X}_{it}$ is a matrix of control variables including the regional level of deterrence, the regional income opportunities and time dummies for the years 2005, 2006 and 2007, β_4 is a vector of the corresponding regression coefficients, and ϵ_{it} is a standard error term. Finally, $B_i T_{it}$ is the interaction term of B_i and T_{it} that takes the value 1 for border regions in 2008. The coefficient β_3 then measures the divergence in average outcomes between the border regions, i.e. treatment group, and non-border regions, i.e. control group, in 2008, which indicates the Average Treatment effect of the Treated (ATT). This is the effect of interest, i.e. the Schengen effect.

The matching procedure outlined above contributes to the conditional independence assumption holding. Hence, it ensures that the difference before and after the treatment in the absence of the treatment are similar conditioned on the propensity of being a bor-

der region, P(**X**), that is expressed by the propensity score. Along with the conditional independence assumption, a second key initial assumption is the Stable Unit Treatment Value Assumption (SUTVA), requiring that potential outcomes of units are unaffected by the exposure to the treatment of other units (Rubin, 1980; Stuart and Rubin, 2008). This assumption, often referred to as the non-macro effect assumption, is more difficult to justify. Hence, the abolishment of border controls inevitably affected all German regions, not only regions located on the border to the two new Schengen member states. The identified effect can thus only be interpreted as the lower bond of the true effect.

To increase the efficiency of the estimates further, a set of regional covariates that may affect crime rates within regions is included in the regression model. The set of covariates includes the regional level of deterrence, indicated by the regional clearance rate and the regional economic performance, measured by the regional GDP per capita and the regional GDP growth rate. The regional population density is included as a further region-specific variable. As indicated above, these variables are frequently identified in the geography of crime literature as factors affecting the crime rate in a given region. Data on all regional characteristics are again compiled from Eurostat (2016), the Cambridge Regional Econometrics Database (2015), the INKAR data of the German Federal Institute for Research on Building, Urban Affairs and Spatial Development (2016), and the German Police Crime Statistics of the Federal Criminal Police Office (Bundeskriminalamt, 2005 to 2009).

3.4 Empirical Results

3.4.1 All Crimes

Table 3.3 depicts the estimated regression coefficients and the corresponding robust standard errors of the linear difference-in-difference regression model on matched samples. The first model specification depicts the results without the inclusion of any covariate, while the subsequent model specifications include region-specific covariates that are commonly identified as affecting crime rates at the regional level. The second model specification includes the regional clearance rate, while the third and fourth model specifications also include the regional economic performance and the regional population density.

Table 3.3: Difference-in-Difference Estimates on Matched Samples: All Crimes[a]

	All Crimes	All Crimes	All Crimes	All Crimes
DID	-1.396	-2.559	-.047	2.978
	(2.945)	(3.099)	(3.619)	(3.048)
Year=2008	-3.977	-4.681	-2.210	-2.337
	(2.054)	(2.382)	(3.994)	(4.339)
Border=1	-5.986	-5.425	-3.332	-5.082
	(14.98)	(14.54)	(13.49)	(11.77)
Clearance Rate		-.577	-.853	.508
		(.985)	(.841)	(.712)
GDP per capita			.002	-.001
			(.001)	(.001)
GDP Growth Rate			-306.5*	-197.2*
			(123.5)	(85.82)
Pop. Density				.126***
				(.034)
Yearly Dummies	√	√	√	√
Constant	78.81***	114.9	83.26	23.23
	(8.991)	(65.88)	(67.71)	(54.32)
Onservations	270	270	270	270
McFadden's R^2	-.018	-.018	.104	.312

[a] Table entries denote estimated coefficients, robust standard errors (in parentheses) and the level of significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The estimated coefficients in Table 3.3 show that the interaction term, (DID), which constitutes the parameter of interest, is negative and not statistically significant in the first specification. This indicates that the number of crimes per 1,000 inhabitants in German regions on the border to Poland and the Czech Republic did not change in a statistically significant way compared to their non-border counterparts after Poland and the Czech Republic implemented the Schengen Acquis. The result stays the same when controlling for the regional clearance rate and the regional economic performance. When further controlling for the population density, the interaction term becomes positive, but stays statistically insignificant. The binary variables for the year 2008 and the border location are also not statistically significant in all four model specifications, which means that crime rates in border and non-border regions did not differ during the entire observation period, i.e. 2004 to 2008, and that crime rates in border regions and in their matched control regions did not change significantly between the pre-Schengen, i.e. 2004 to 2007, and the post-Schengen period, i.e. 2008.

Regarding the estimated coefficient of the various covariates, results show that the regional economic growth rate and the regional population density both have a statistically significant effect on crime rates. The positive regression coefficient for population density suggests that more densely populated areas witness higher crime rates. This finding is

in line with the geography of crime literature, suggesting that in more populated, i.e. urban regions, crime rates are higher (Sampson *et al.*, 1997; Entorf and Spengler, 2000). When looking at the regional economic performance indicators, results show that the GDP per capita has no significant effect, while the regional economic growth rate has a statistically significant, negative effect. These findings suggest that in the case of German regions bordering Poland and the Czech Republic and their matched non-border control regions, economically more prosperous regions ceteris paribus witnessed lower crime rates. This result fits with the theoretical consideration of Ehrlich (1973), who proposes that economically prosperous regions provide better legal income opportunities. It does, however, contradict the argument that more prosperous regions are endowed with more transferable assets and may hence constitute more lucrative targets for offenders from outside the region (see Entorf and Spengler, 2000 for a detailed discussion). In contrast to the regional economic growth rate and regional population density, the regional clearance-rate, which measures the regional level of deterrence, does not have a statistically significant effect on crime rates in German border regions and their matched controls.

3.4.2 Crimes Against Poverty

Table 3.4 depicts the estimated regression coefficients with the rate of crimes against poverty as the outcome variable. Crimes against poverty include burglary, thievery from motor vehicles, criminal mischief, drug-related crimes and street crimes, i.e. all types of crimes against poverty for which regional-level data are available. The interaction term is now positive, but still not statistically significant in all four model specifications. This suggests that the Schengen Acquis and the subsequent abolishment of border controls at the German-Polish and the German-Czech border has also not affected the rate of crimes against poverty in German border regions in a statistically significant way. The binary variables for the post-Schengen period and the border location are again not statistically significant, either. This indicates that crime rates in border regions and their matched control regions did not change before and after the Schengen Acquis in a statistically significant way, and that crime rates in border regions and their matched control regions did not differ during the entire observation period, i.e. from 2004 to 2008.

Table 3.4: Difference-in-Difference Estimates on Matched Samples: Poverty Crimes[a]

	Povery Crime	Povery Crime	Povery Crime	Povery Crime
DID	.760	.669	1.781	1.951
	(1.364)	(1.801)	(2.051)	(1.547)
Year=2008	-.231	-2.977	-4.154	-.779
	(1.606)	(1.571)	(2.142)	(2.335)
Border=1	-3.389	-5.382	-4.731	-3.747
	(5.733)	(5.425)	(5.238)	(4.544)
Clearance-Rate		-.767**	-.714**	-.303
		(.224)	(.214)	(.167)
GDP per capita			.001	-.001
			(.001)	(.001)
GDP Growth			-102.9	-68.65
			(51.81)	(38.51)
Pop. Density				.045**
				(.014)
Year Dummies	√	√	√	√
Constant	30.62***	62.43***	48.90**	37.65*
	(3.763)	(11.39)	(16.32)	(14.91)
Observations	270	270	270	270
McFadden's R^2	-.017	.099	.166	.323

[a] Table entries denote estimated coefficients, robust standard errors (in parentheses) and the level of significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Regarding the regional covariates, results show that for crimes against poverty, regional clearance rates have a statistically significant negative effect. This indicates that for these types of crimes, a higher level of deterrence within a region indeed reduces criminal activities. However, when controlling for the population density, the coefficient for the clearance rate is no longer statistically significant. While the level of economic performance within a region has no statistically significant effect, the regression coefficient for the regional population density is positive and statistically significant, indicating that crime rates are again higher in urban regions compared to rural ones.

Tables 3.5 and 3.6 depict the estimated regression coefficients for various types of criminal offenses as the outcome variable. The findings show that the interaction term, indicating the Schengen effect, is not statistically significant for thievery from motor vehicles (Table 3.5), drug-related crimes (Table 3.5), criminal mischief (Table 3.6) and street crimes (Table 3.6).

Table 3.5: Difference-in-Difference Estimates on Matched Samples: Various Types of Crimes I[a]

	Burglary				Thievery from Motor Vehicles				Drug Related Crimes			
DID	.496**	.518*	.544**	.548**	-.214	-.210	-.138	-.132	.237	.223	.264	.273
	(.180)	(.209)	(.203)	(.203)	(.372)	(.365)	(.344)	(.350)	(.270)	(.272)	(.307)	(.301)
Year=2008	-.616*	-.621*	-.669*	-.615*	-.906**	-.909**	-1.083**	-.890**	-.953***	-.976***	-1.259***	-1.167***
	(.185)	(.192)	(.199)	(.195)	(.292)	(.294)	(.320)	(.326)	(.208)	(.212)	(.322)	(.310)
Border=1	-.490*	-.501*	-.499*	-.503**	-.126	-.128	-.060	-.070	-.455	-.359	-.220	-.247
	(.191)	(.205)	(.199)	(.182)	(.758)	(.753)	(.738)	(.697)	(.639)	(.613)	(.552)	(.541)
Clearance-Rate		.001	.001	.001		-.003	-.004	-.001		-.064*	-.080**	-.066*
		(.001)	(.001)	(.001)		(.017)	(.017)	(.015)		(.030)	(.024)	(.030)
GDP per capita			.001	-.001			.001	-.001			.001	.001
			(.001)	(.001)			(.001)	(.001)			(.001)	(.001)
GDP Growth			-.647	.370			-8.504*	-4.967			-9.098*	-7.531*
			(.899)	(.910)			(3.777)	(2.626)			(4.046)	(3.726)
Pop. Density				.001**				.004***				-.002
				(.001)				(.001)				(.001)
Year Dummies	√	√	√	√	√	√	√	√	√	√	√	√
Constant	1.233***	1.151***	.604	.785	3.069***	3.133***	1.553	2.122*	3.410***	9.433**	8.263**	7.252*
	(.176)	(.212)	(.375)	(.406)	(.344)	(.498)	(.952)	(.991)	(.386)	(3.346)	(2.803)	(3.218)
Observations	270	270	270	270	270	270	270	270	270	270	270	270
McFadden's R^2	.089	.087	.124	.238	-.004	-.008	.049	.153	-.001	.020	.218	.241

[a] Table entries denote estimated coefficients, robust standard errors (in parentheses) and the level of significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3.6: Difference-in-Difference Estimates on Matched Samples: Various Types of Crimes II[a]

	Criminal Mischief				Street Crime			
DID	.115	.061	.495	.580	.363	.116	.872	1.050
	(.491)	(.469)	(.602)	(.550)	(.884)	(1.152)	(1.146)	(.915)
Year=2008	1.384**	1.081	.950	1.979*	-.093	-.203*	-.872	.213
	(.499)	(.700)	(.784)	(.809)	(1.011)	(1.124)	(1.506)	(1.574)
Border=1	-.666	-1.082	-.507	-.139	-2.107	-3.053	-2.577	-2.108
	(1.896)	(1.822)	(1.911)	(1.464)	(3.250)	(3.153)	(3.216)	(2.795)
Clearance-Rate		-.100	-.001	.092		-.528*	-.404	-.133
		(.124)	(.104)	(.097)		(.211)	(.219)	(.188)
GDP per capita			.001	-.001			.001	-.001
			(.001)	(.001)			(.001)	(.001)
GDP Growth			-34.50*	-20.24			-61.22	-41.80
			(16.71)	(11.41)			(35.35)	(27.12)
Pop. Density				.019***				.026**
				(.005)				(0.008)
Year Dummies	√	√	√	√	√	√	√	√
Constant	9.961***	13.56**	6.467	5.104	16.40***	30.64***	21.86	17.10
	(1.295)	(4.821)	(6.358)	(6.787)	(2.301)	(6.920)	(11.52)	(11.00)
Observations	270	270	270	270	270	270	270	270
McFadden's R^2	-.014	-.009	.043	.326	-.015	.053	.106	.284

[a] Table entries denote estimated coefficients, robust standard errors (in parentheses) and the level of significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

This indicates that for these types of criminal offenses, the abolishment of border controls at the Polish-German and Czech-German border did not affect crime rates in German border regions in a statistically significant way. The Schengen effect is, however, positive and statistically significant for burglaries (Table 3.5), indicating that the Schengen Acquis and the subsequent abolishment of border controls indeed affected the number of reported burglaries per inhabitant in German regions on the border to Poland and the Czech Republic. In the baseline specification, i.e. the specification without any region-specific covariate, the estimated coefficient has a value of .496, which is difficult to interpret in terms of effect size. When taking the natural logarithm of crime rates as the dependent variable, the estimated regression coefficient amounts to .527, which indicates that because of the removal of border controls, crime rates in border regions increased by 52.7% compared to non-border regions, which is a comparatively large effect (see Table I.33 in Appendix Part I). The positive effect remains similar when controlling for region-specific covariates. This finding indicates that public concerns that the removal of physical barriers at the German-Polish and German-Czech border would increase crimes in border regions are not completely unjustified.

Yet results also reveal that the positive effect is mainly driven by a sharp decrease in burglaries in the matched control regions in 2008. As Figure 3.7 illustrates, the rates of

burglaries sharply decreased in the matched non-border regions in 2008, whereas in border regions, the rate of burglaries stayed more or less the same between 2007 and 2008. The negative and statistically significant coefficient for the border location dummy variable also depicts that border regions actually witnessed fewer burglaries per 1,000 inhabitants than their non-border matched controls in the entire observation period. The negative effect for the 2008, i.e. post-Schengen, dummy reveals that the rate of burglaries decreased after the Schengen Acquis in border regions and their matched controls.

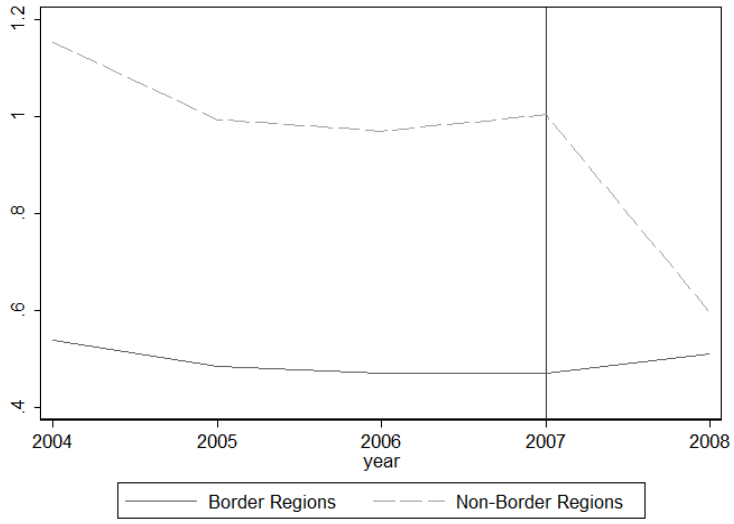


Figure 3.7: Rate of Burglaries in Border Regions and Matched Non-Border Regions 2004-2008
The rate of burglaries indicates the number of reported burglaries per 1,000 inhabitants.

The estimated coefficients of the post-Schengen dummy variables are also negative and statistically significant for drug-related crimes and thievery from motor vehicles, indicating that these types of crime also deceased in 2008 compared to the pre-Schengen period in both border regions and their matched control regions (Table 3.5). For the remaining types of criminal offenses, the estimated coefficients for the 2008 dummy variable are, overall, not statistically significant. Regarding the border location, the estimated coefficients are negative for all five types of criminal offenses under consideration. However, the effects are only statistically significant for burglaries, whereas in the other crime types, the rates did not differ between border regions and their matched controls in a statistically significant way between 2004 and 2008.

Regarding the region-specific covariates, results show that the regional level of deterrence, measured through the regional clearance rate in a particular type of crime, does not yield a statistically significant effect for any of the five types of criminal offenses, except for drug-related crimes. Here, the corresponding regression coefficient is negative and statistically significant, indicating that the higher the regional clearance rate (in drug-related crimes) is, the lower is the crime rate in drug-related crimes. The coefficient is also statistically significant for street crime, but becomes insignificant when controlling for the regions' economic performance and population density.

With respect to the economic indicators, results show that the regional GDP per capita does not have a statistically significant effect on crime rates in border regions and their matched controls. In contrast, the economic growth rate has a statistically negative effect on the crime rates in drug-related crimes, suggesting that drug-related crimes are less frequent in economically prosperous regions. Effects are also negative and significant for street crime and thievery from motor vehicles, as long as the regional population density is not included in the model. The negative effects support the view that better legal income opportunities reduce crime; yet they stand in contrast to the assumption that economically prosperous regions should witness more crimes given their relative higher endowment with transferable assets. Regarding the population density, the regression coefficients are positive and statistically significant for all five types of criminal offenses, except for drug-related crimes. This indicates that more densely populated regions ceteris paribus witness higher crime rates in these types of criminal offenses. For drug-related crimes, the regression coefficient for population density is negative, suggesting that drug-related offenses are also common in less populated, rural regions. This finding is in line with recent media reports about an increase in drug abuse in rural Saxon and Bavarian regions located near the border to the Czech Republic (Bayerisches Landesamt für Gesundheit und Lebensmittelsicherheit, 2016).

Overall, the empirical analysis shows that the abolishment of border controls on the German-Polish and German-Czech border had no effect on overall crime rates as well as on crime rates in the common types of poverty crimes in German border regions. One potential explanation for the insignificant effect may be that the risk perception and anticipated benefits of criminal activities in German border regions have not changed for potential offenders from the East after border controls were abolished. Another ex-

planation may be the reinforcement of police presence in the immediate border regions once border controls were eliminated. In fact expenditures to the police increased in all four Federal States bordering either Poland or the Czech Republic increased from 2006 to 2008. For the rate of burglaries, however, a positive and statistically significant effect can be observed. This finding supports public concerns that the abolishment of border controls would increase crime. Public concerns may be reinforced by the fact that burglaries are one of the most feared types of criminal offenses in Germany (Hirtenlehner and Hummelsheim, 2015). Indeed, in a survey conducted by the German Police Crime Office in 2014, the fear of burglaries ranked even above the fear of robbery or rape among the German public (Hirtenlehner and Hummelsheim, 2015). This may explain the public concerns revealed, despite the fact that compared to other types of criminal offenses, the number of burglaries per 1,000 inhabitants in border regions is quite low and increased only slightly between the pre-Schengen and post-Schengen period in these regions.

3.5 Discussion and Conclusion

This essay has assessed whether the abolishment of border controls at the German-Polish and German-Czech border in December 2007 affected crime rates in German regions located on the border to Poland and the Czech Republic based on annual panel data of German counties (Landkreise) for the years 2004 to 2008. Effects were identified by conditional difference-in-difference estimation on matched samples. This approach allows the identification of the Schengen effect on crime rates in border regions in a causal way. Results show that no significant Schengen effect can be observed for overall crime rates. However, for the rate of burglaries, the data reveal a positive and statistically significant effect, indicating that for burglaries, public concerns about an increase in crime following the Schengen Acquis proved to be true. The identification strategy, however, also shows that the effect is primarily driven by a sharp decline of burglaries in the matched control regions instead of a sharp increase of burglaries in border regions. Moreover, results reveal that for other, more common types of criminal offenses, including criminal mischief, street crime, thievery out of motor vehicles or drug-related crimes, the abolishment of border regions had virtually no effect on crime rates in border regions.

Even though the results provide initial empirical evidence of the causal effect of the abolishment of border controls on crime rates in border regions, some empirical caveats have to be noted. Firstly, the Stable Unit Treatment Value Assumption (SUTVA) may not hold in the context of this essay. Hence, along with the border regions, the remaining German regions were also affected by the elimination of border controls, and spatial spillover effects cannot be ruled out. The findings can hence only be interpreted as lower bonds of the true effects. Secondly, the number of border regions is very low, which reduces the power of the estimation. Moreover, it is possible that results are driven by a few outlier regions with regional peculiarities. To increase the number of observations, it may be worthwhile in future research to conduct sub-regional-level analyses, for example for German municipalities bordering Poland or the Czech Republic. However, crime data on this sub-regional level may prove difficult to obtain. Thirdly, the empirical analysis is constrained to the time period from 2004 to 2008 and includes only one year for the post-Schengen period. The results, therefore, only indicate the short-term effect, but do not allow any conclusions about medium-term or long-term effects. Finally, the essay does not assess potential channels through which the removal of physical barriers affects burglaries in border regions. In future research, it may hence be desirable to consider the type of border adjacency, the physical infrastructure and trade routes between German border regions and their Polish and Czech counterparts. This would allow conclusions about the relevance of these factors that are frequently identified in the literature as spurring border regions' susceptibility to crime (see, for example, Ceccato and Haining, 2004, Johnson; 2014 or Wilson, 2009). Furthermore, it may be of interest to expand the empirical analysis to non-border regions that are direct or indirect neighbors of border regions. This would allow the tracing of the spatial dimension of the Schengen effect on regional crime rates.

Despite these caveats, the essay still offers an initial attempt to empirically identify and evaluate the causal effect that the abolishment of border controls at the German-Polish and German-Czech border had on crime rates in German border regions. Results show that for overall crime rates, no significant increase in crime rates can be observed. Hence, in contrast to public concerns, border regions have not per se experienced an increase in crime rates as a result of the implementation of the Schengen Acquis in Poland and the Czech Republic. However, for burglaries, a statistically significant positive effect

is visible, indicating that public concerns are not completely unjustified. Against this background, public authorities would do well to counteract criminal activities in border regions more intensively. This would also signal political awareness, which may decrease public concerns and the drift of voters in border regions to populist or even nationalist parties that exploit public fears. At the same time, the empirical results show that for other types of criminal offenses such as street crime, thievery of motor vehicles, criminal mischief or drug-related crimes, the Schengen Acquis had virtually no effect on crime rates in German border regions. In light of the prevailing xenophobic tendencies especially in East German border regions and the current discussion on the future of the Schengenzone and borderless Europe, this is quite a relevant result, because it shows that that at least for border regions at the German-Polish and German-Czech border, there is only little empirical support for the widespread concerns about public security.

Chapter 4

Firm-Specific and Region-Specific Factors and Spatial Cooperation Patterns of Lower Bavarian Firms*

This essay examines spatial cooperation patterns of firms in Research and Development (R&D) and assesses the relative influence of firm-specific and region-specific factors on these patterns. Results, which are based on genuine micro data of 221 firms located in the German region of Lower Bavaria, suggest that characteristics of the cooperation regions are relatively more influential for firms' spatial cooperation patterns than firm-specific ones. Thereby, the regional knowledge base and the function that a region fulfills within the value chain of a firm seem to be equally influential than common factors such as the geographical and institutional proximity of a region. Translated into the political context, these findings suggest that regional stakeholders and policy makers should consider region-specific patterns along with firm-specific ones when designing regional cooperation strategies.

Keywords: R&D Cooperation, Spatial Cooperation Patterns, Low-Technology Region, German Firms

JEL Classification: R11, R12, R14, L20

*The Chapter has profited from constructive comments from participants of the Doctoral Day of the Regional Innovation Policy Conference 2015.

4.1 Introduction

Cooperation with other organizations, such as other firms, universities or research institutes, is one channel through which firms can absorb external knowledge that is beneficial for their innovativeness and economic prosperity. Hence, strengthening firms' connectivity, i.e. their cooperation linkages with external partners, has become a key element of regional growth and development policies in Europe (see Camagni *et al.*, 2014; Camagni and Capello, 2013; McCann and Ortega-Argilès, 2015). The Europe 2020 strategy of the European Commission, for example, highlights the relevance of cooperation with external partners and recommends integrating inter-regional cooperation strategies in regional development policies (European Commission, 2010). Particularly for firms located in peripheral, low-technology regions, i.e. regions with a low population density, no major city and a dominance of low- and medium-technology industries, cooperation with inter-regional partners can constitute an important instrument with which to overcome the limited regional knowledge bases (Grillitsch and Nilsson, 2015; Grillitsch and Trippl, 2013). At the same time, models of spatial knowledge acquisition suggest that geographic proximity is highly important, as it facilitates face-to-face contact and mutual trust, which are preconditions for successful cooperation (Asheim and Gertler, 2005; Malmberg and Maskell, 2006).

This essay examines firms' spatial cooperation patterns in Research and Development (R&D) based on a sample of 221 firms located in the German low-technology border region of Lower Bavaria. R&D cooperation is defined here as cooperation between two or more parties that aim to develop new products or processes and that exceed pure market relations. Along with a detailed description of spatial cooperation patterns in R&D of Lower Bavarian firms, this essay addresses in particular the question of the relative influence of firm-specific factors, such as the size or sector of a firm, and region-specific factors, like geographical or institutional proximity, on firms' spatial cooperation patterns. Knowing the relative influence of these factors can provide valuable insights for regional stakeholders and policymakers when designing regional policy strategies. Hence, it allows recommendations as to whether programs, aiming to foster cooperation between firms and other actors, should focus on firm-specific factors, for instance specific support for SMEs, or on region-specific patterns.

The essay applies multinomial logit and conditional logit models to assess the relation between firms-specific as well as region-specific factors and firms' spatial cooperation patterns in R&D. While a multinomial logit model is applied to analyze the influence of various firm-specific factors, a conditional logit models is applied to simultaneously assess the relative influence of both firm-specific and region-specific factors. Results indicate that when firm-specific and region-specific factors are assessed simultaneously, the latter are relatively more influential on firms' spatial cooperation patterns. The function that a specific region fulfills within the value chain of an individual firm as well as the presence of a relevant university or research institute within a region are equally important than common factors such as the geographical and institutional proximity of a region vis-à-vis Lower Bavaria. These findings indicate that universities and research institutes are relevant partners in R&D for firms in rural, low-technology regions. Moreover, results show that firms' spatial operation radii are constrained, as firms tend to engage in R&D cooperation mainly with partners in regions that are also of functional, i.e. market importance to them.

Translated into the political context, the results suggest that regional stakeholders and policy makers should consider region-specific patterns along with firm-specific characteristics when designing regional cooperation strategies. In particular, they should strengthen the regional knowledge base and foster local and regional university-industry linkages. At the same time, they should promote interregional cooperation initiatives and incentivize firms to search for cooperation partners outside their usual spatial operation radii.

The remainder of the essay is structured as follows: Section 4.2 provides an overview of the literature on spatial cooperation patterns of firms and the relation between firm-specific and region-specific characteristics and these spatial patterns. Section 4.3 introduces the estimation strategy and the survey data of Lower Bavarian firms. The empirical results are presented and discussed in Section 4.4. Section 4.5 concludes.

4.2 Spatial Cooperation Patterns of Firms in Peripheral Regions

In the literature, there is a broad consensus that Research and Development (R&D) cooperation is beneficial for the innovativeness of firms. Hence, R&D cooperation with other firms, universities or research institutes enables firms to exploit external knowledge and absorb new ideas (see, for example, Becker and Dietz, 2004 for the German context). Regarding the spatial dimension of R&D cooperation, firms can choose from a variety of spatial cooperation options. They can cooperate predominantly with partners from the same region or with partners from outside the region. Equally, they can predominantly cooperate with domestic partners or with international partners.

Recent empirical evidence shows that firms in peripheral regions profit especially from cooperation with partners from outside the region, as these cooperation-linkages can enable firms to exploit specific knowledge that is not present within the region (see, for example, Fitjar and Rodríguez-Pose, 2011; Grillitsch and Nilsson, 2015; Grillitsch and Trippl, 2013). At the same time, theories on the spatial acquisition of knowledge suggest that knowledge transfer is facilitated by geographical as well as cultural and institutional proximity, given the tacit nature of knowledge and the embeddedness of knowledge in the local or regional socioeconomic, cultural and institutional context (see Gertler, 2003; Malmberg and Maskell, 2006). While cultural proximity refers to a common language, culture and history, institutional proximity refers to a common political-institutional system and a common legal framework (Boschma, 2005). For R&D cooperation in particular, which mainly deals with the transmission of knowledge instead of the exploitation of pure price effects, these soft factors may play an important role in enhancing cooperation.

Based on existing conceptional approaches to spatial knowledge acquisition and recent empirical studies, the following sections assesse two sets of factors that potentially influence the spatial cooperation patterns of firms in low-technology regions. The first set includes firm-specific characteristics such as the size or sector of the firm, while the second set includes region-specific characteristics such as the regional geographical or institutional proximity of a region to Lower Bavaria.

4.2.1 Firm-Specific Factors and Firms' Spatial Cooperation Patterns

In the literature, the vast majority of studies, which examine the determinants of firms' R&D cooperation strategies, focus on the impact of firm-specific factors such as the size or sector of a firm. Regarding the initial cooperation decision of firms, i.e. the decision to engage in R&D cooperation, the size and sector of a firm, and its R&D intensity are frequently identified as decisive factors for explaining cooperation decisions of firms (see Barge-gil, 2010 for an overview). The idea is that larger firms have greater capacity and resources to search for cooperation partners and manage cooperation. Consequently, they may be more likely to cooperate (see, for example, Veugelers, 1998). Similarly, firms in high-technology industries and firms with a high R&D intensity are more likely to cooperate, as their research and development process is usually more complex, requiring the acquisition of external knowledge (see, for example, Tödtling *et al.*, 2006). At the same time, innovative firms frequently command a higher absorptive capacity, enabling them to profit from R&D cooperation (see, for example, Cohen and Levinthal, 1990).

Studies which explicitly emphasize the choice between various cooperation options are less frequent. Also, they predominately focus on the choice between horizontal cooperation, i.e. cooperation with competitors, and vertical cooperation, i.e. cooperation with suppliers and customers. Kaiser (2002), for instance, finds that firm size and firm location can explain the choice between vertical, horizontal and mixed cooperation of firms in the German service sector. Similarly, Miotti and Sachwald (2003) show for French manufacturing firms that the technological intensity of the firm best explains the choice between horizontal and vertical cooperation. For a sample of Dutch firms, Belderbos *et al.* (2004) identify firm size and R&D intensity as the main explanatory factors driving the choice between competitors, suppliers, customers and research institutes as cooperation partners, while Franco and Gussoni (2010) find for Italian manufacturing firms that the size and sector of the firm as well as the level of firms' R&D expenditure determine the choice between market and research cooperation. Considering the spatial dimension of cooperation, i.e. the choice between partners from various regions, Arranz and Fernandez de Arroyabe (2008) show that the technological intensity as well as the firm size can explain the choice between domestic, EU and US partners of Spanish manufacturing

firms, whereas Miotti and Sachwald (2003) identify the same variables as factors that explain the likelihood of French firms cooperating with partners from the US and Japan.

These studies show that firm-specific factors, particularly the size and sector of a firm and a firm's R&D intensity, can contribute a great deal towards explaining firms' R&D cooperation patterns. Yet these firm-specific factors may not be the only ones that matter. In the spatial context in particular, characteristics of the alternative cooperation regions may be equally important.

4.2.2 Region-Specific Factors and Firms' Spatial Cooperation Patterns

In the past decades, several models of knowledge acquisition have been introduced that emphasize the spatial dimension of cooperation of firms. The Regional Innovation System (RIS), for instance, stresses the relevance of geographical proximity for knowledge creation and knowledge diffusion between actors (Asheim, 1996; Asheim and Gertler, 2005; Cooke, 2001). This idea is similar to the one outlined in the regional geography's cluster literature (Porter, 2000), suggesting that an agglomeration of cooperating firms within a region can increase the regions' innovativeness. However, it may not only be geographical proximity that supports intra-regional cooperation. As Boschma (2005) points out, cultural and institutional proximity may be equally important. The idea is that cooperation with partners, who speak the same language, share a common culture and operate within the same political-institutional system, may be less expensive in terms of transaction costs than cooperation with culturally or institutionally more distant partners (Lundquist and Trippl, 2013; Trippl, 2010). Consequently, firms may gain the highest utility from engaging in R&D cooperating with partners in geographically, culturally or institutionally close regions.

For R&D cooperation, however, transaction costs may be less important than for procurement or production cooperation, with the acquisition of complementary knowledge possibly being the main motivation for firms' cooperation (Miotti and Sachwald, 2003; Tether, 2002). From this resource-based perspective, firms located in regions with a limited knowledge base, such as peripheral, low-technology regions, may profit in particular

from cooperating with external partners. Hence, cooperation with partners from outside the region can enable firms to overcome the limited regional knowledge base and to exploit external knowledge (Bathelt *et al.*, 2004). This perspective has been supported by recent empirical works indicating that firms in peripheral regions are more likely to innovate when they cooperate with partners from outside the region (see, for example, Grillitsch and Nilsson, 2015; Grillitsch and Trippl, 2013). Hence, the knowledge base that a region provides for a firm may be a further relevant factor for firms' spatial cooperation patterns.

A third region-specific factor that may influence firms' spatial cooperation patterns is the functional, i.e. market, importance that a region has for an individual firm. The idea is that particularly Small and Medium-size Enterprises (SMEs) lack the financial and personal resources to engage in cooperation with partners in multiple regions. Instead, firms may be constrained in their spatial operation radius and engage in R&D cooperation with partners from regions that are also of market importance to them. Consequently firms that operate mainly on local markets may, ceteris paribus, tend to engage in R&D cooperation primarily with local partners, whereas firms operating on interregional or international markets may, ceteris paribus, be more likely to cooperate primarily with partners from outside the region. This argument suggests that the function that a region fulfills within the value chain of a firm may be a further factor that influences firms' spatial cooperation patterns.

To summarize, the literature suggest that both firm-specific and region-specific factors may influence firms' spatial cooperation patterns in R&D. Following an explorative research approach, the remainder of this essay assesses the relative influence of both sets of factors on firms' spatial cooperation patterns on a sample of 221 Lower Bavarian firms. With respect to the characteristics of the individual firm, the empirical assessment distinguishes between the size and sector of the firm as well as firms' R&D expenditure. Regarding the characteristics of the alternative cooperation regions, the focus is on the relative influence of the geographical and institutional proximity of a region vis-à-vis Lower Bavaria as well as on the regional knowledge base and on the market function that a region fulfills within the value chain of a firm.

4.3 Empirical Analysis

4.3.1 Estimation Strategy

To examine the relative influence of firm-specific and region-specific factors on firms' spatial cooperation patterns, several specifications of multinomial choice models are estimated. From a conceptual point of view, multinomial choice models are based on the standard random utility maximization framework, assuming that firms are utility maximizers and choose the alternative with the highest utility (see McFadden, 1974; Train, 2009 for and overview). Translated in the context of firms' spatial cooperation patterns, this means that firms predominantly cooperate with partners in that region with the highest utility for them.

Following the literature on the standard random utility maximization framework (see Long and Freese, 2006; McFadden, 1974; Train, 2009), the utility U a firm i attaches to each of the alternative cooperation regions j, i.e. U_{ij}, is expressed as a function V of firm-specific factors x_i of firm i and region-specific factors z_j of an alternative cooperation regions j. As firms are assumed to be utility-maximizers, they choose to cooperate with partners from region m from a set of alternative regional options J, when $U_{im} > U_{ij}, \forall$ m, j $\in J$ and $m \neq j$. The probability of a firm i choosing region m is then given as:

$$P(y_i = m) = P(U_{im} > U_{ij}), \forall \text{ m} \neq \text{j}$$

When the function V only contains firm-specific factors, instead of firm-specific and region-specific ones, a multinomial logit model can be estimated. The probability of choosing region m out of a set of J possible alternative regions j is then given as a function V of the observable firm-specific characteristics x of firm i, and the parameter-vector β, and the error term ϵ_{ij}. Hence, the model can be formalized as:

$$Pr(m) = V(x_i; \beta; \epsilon_{ij}), \forall \text{ } m, \text{ } j \text{ } \in J_i \text{ and m} \neq j$$

Under the assumption that the error terms follow an extreme value distribution of type I, the probability of choosing alternative m is then given by:

$$P(y_i = m) = \frac{exp(V_{im})}{1 + \sum_{j=2}^{J} exp(V_{ij})}$$

The denominator indicates that in order to estimate the regression coefficients, one alternative has to be fixed. This alternative serves as the reference group in the estimation (for a detailed discussion of the model see, for example, Long and Freese, 2006 or Train, 2009).

However, this essay aims at assessing not only the influence of firm-specific factors on firms' spatial cooperation patterns; instead it pursues to also examine the relative influence of both firm-specific and region-specific factors on these patterns. Therefore, it is crucial to include both sets of factors in one and the same model. When both firm-specific and region-specific factors are simultaneously assessed, the multinomial logit model is no longer appropriate. Instead, a conditional logit model is more suitable, as this model allows the simultaneous inclusion of both sets of factors in one and the same model. In the conditional logit model, the probability of choosing region m out of a set of J alternative regions is then modeled as a function V that includes not only observable firm-specific characteristics x of firm i, but also observable characteristics of region m, i.e. z_m as well as observable characteristics of all other regions j, i.e. z_j. The model can then be formalized as follows:

$$Pr(m) = V(z_m; z_j; x_i; \beta; \epsilon_{ij}), \forall \text{ m, j } \in J_i \text{ and m} \neq j$$

Again under the assumption that the error terms follow an extreme value distribution type I, this probability is given by:

$$P(y_i = m) = \frac{exp(V_{im})}{\sum_{j=1}^{J} exp(V_{ij})}$$

(see Long and Freese, 2006 or Train, 2009). The multinomial logit and conditional logit model are the standard econometric models of firms' spatial location decisions (see, for

example, Alamá-Sabater *et al.*, 2011; Autant-Bernard, 2006; Carlton, 1983). Hence, it seems appropriate to apply these models in the context of spatial cooperation decisions as well. Yet both models make quite strong assumptions. In particular, they assume that the choices are Independent of Irrelevant Alternatives (IIA) (McFadden, 1974). In the context of spatial cooperation patterns, this would mean that firms would choose their main cooperation region in R&D with the same probability, even if they face fewer or more alternatives. This assumption may not hold and more complex models such as mixed logit or multinomial probit models that relax the IIA assumption may be more appropriate. However, several studies have pointed out that especially in the case of small sample size and few alternatives, these more complex models frequently fail to converge at a global optimum or produce imprecise parameters (see, for example, Dow and Endersby, 2004; Geweke *et al.*, 1994; Horowitz, 1980; Quinn *et al.*, 1999). Furthermore, empirical applications have shown that in many cases, the IIA assumption is not very restrictive or relevant (Dow and Endersby, 2004). Given these caveats of more complex models in small samples, it seems appropriate to use the simpler multinomial logit and conditional logit model in the context of firms' spatial cooperation decisions. However, it is important to note that as the IIA assumption may not hold in the context of firms' spatial cooperation choices, the results only reveal statistically significant correlations between firm-specific and region-specific factors as well as spatial cooperation patterns of firms, and cannot be interpreted in a causal way.

4.3.2 Study Region and Firm Data

As outlined above, the empirical analysis is based on original micro-data obtained from a survey of firms located in the German NUTS-2 region of Lower Bavaria. This region offers an interesting case to study, as it is located in the southeastern most corner of Germany, directly on the border to Austria and the Czech Republic. This location provides regional firms with different cooperation options within the same geographic radius (see Figure 4.1). Hence, regional firms can cooperate predominantly with local partners or with partners from the remainder of Germany. Similarly, they can cooperate predominantly with German partners or with partners from abroad.

Figure 4.1: Map of Lower Bavaria and Surrounding Regions
Map of Lower Bavaria and the surrounding German, Austrian and Czech regions, whereby Lower Bavaria is depicted in dark coloring and Bavaria in grey coloring.

In terms of the regional socio-demographical structure, Lower Bavaria can be described as a peripheral region. Its population density is below 120 inhabitants per squared km, and the three largest cities Landshut (ca. 67,500 inhabitants), Passau (ca. 50,000 inhabitants) and Straubing (ca. 46,000 inhabitants) do not represent major agglomeration centers (Industrie- und Handelskammer Niederbayern und Handwerkskammer Niederbayern-Oberpfalz, 2012). In terms of industrial structure, the region is characterized by a dominance of Low and Medium-Technology (LMT) industries such as the vehicle manufacturing and engine building industry, and the wood, metal and glass industry. The largest enterprise located in the region is BMW, operating a major production plant in Dingolfing. Except for this major plant and a few more firms with more than 100 employees, Small and Medium-sized Enterprises (SME) dominate within the region (Industrie- und Handelskammer Niederbayern und Handwerkskammer Niederbayern-Oberpfalz, 2012). In terms of economic performance, the region is quite successful. In 2013, the year when the firm survey was conducted, the regional Gross Domestic Product (GDP) per capita amounted to 32,000 Euro, which was only slightly below the German average (32,600 Euro). In the same year, the regional unemployment rate of 3.5% was well below the German average (6.7%). However, despite its economic success, Lower Bavaria realizes comparatively low values on the traditional innovation-supporting indicators such R&D expenditure and human resources in science and technology (Eurostat, 2016).

The firm data used in the empirical analysis are derived from a survey of Lower Bavarian firms that was conducted between February and April 2013 in a joint research project of the Lower Saxony Institute of Economic Research (Niedersächsisches Institut für Wirtschaftsforschung, NIW), the Lower Bavarian Chamber of Commerce (Industrie- und Handleskammer Niederbayern, IHK Niederbayern) and the Chamber of Handicrafts of Lower Bavaria and Upper Palatinate (Handwerkskammer Niederbayern Oberpfalz). The cooperation with the regional chambers granted access to the chambers' firm databases and enabled the drawing of firms' contact information from these databases. Due to the compulsory membership of German firms in one of the chambers, these datasets include the entire population of regional firms. However, firms with an annual turnover below 17,500 Euro were excluded from the survey, as these firms constitute micro-firms without relevant R&D cooperation-linkages. Overall, 732 Lower Bavarian firms participated in the survey, reflecting a return rate of 13.7%. Several representativity tests have shown that the realized sample is representative for the entire population of regional firms in terms of firm size and geographical location (see Tables II.1 to II.3 in Appendix Part II). However, due to item-non response, not all firms are included in the empirical analysis.

The advantage of the original data compared to standard innovation survey data, such as data from the Community Innovation Survey (CIS) (Zentrum für Europäische Wirtschaftsforschung, 2011 and 2014), is that they provide detailed, small-scale information on the main cooperation region of firms. This detailed inquiry, however, comes at the cost that data are not publicly accessible and are only available for firms in one specific region and for one year. This naturally constrains the external validity of the results. It is thus not possible to analyze variation over time and space or to model dynamic processes. Despite these limitations, the data still offer an initial, cross-sectional glance at statistically significant correlations between firm-specific and region-specific factors and the spatial cooperation decisions of firms located in a peripheral, low-technology border region in Germany.

4.3.3 Variables

4.3.3.1 Dependent Variable

The dependent variable is the main cooperation region of a firm. The main cooperation region is one alternative from a choice set that includes the following five unordered alternatives: (1) same county (Landkreis), (2) Lower Bavaria, (3) Bavaria, (4) Germany, (5) Europe/World[1]. Using the main cooperation region as the dependent variable accounts for the fact that multinomial choice models require the choice alternatives to be mutually exclusive, unordered and complete. Hence, even through firms may cooperate with partners from various regions, they can only have one main, i.e. preferred, cooperation region. As firms could only choose from these regions as their main cooperation region, the choice set can also be regarded as complete. Values for the dependent variable are generated on the basis of firms' information on their main cooperation region in the fields of R&D[2]. To be precise, firms were asked to indicate their main cooperation region in R&D from a list of 26 different regions (see the questionnaire in Appendix Part II.1). Their choices have then been condensed to the five alternatives outlined above. As the summary statistic in Table 4.1 reveals, the vast majority of firms cooperate primarily with partners from the same county (Landkreis) or same region (i.e. Lower Bavaria). In contrast, only few firms indicate that they mainly cooperate with foreign partners. Out of these firms, only a handful cooperates mainly with partners from the neighboring countries Austria and the Czech Republic. These descriptive findings already suggest that geographic and institutional proximity may be important factors for spatial cooperation patterns of regional firms.

4.3.3.2 Firm-Specific Variables

The set of firm-specific factors includes the size and sector of a firm, as well as firms' R&D expenditures. Firm size is measured via the number of employees. Regarding the sector, three binary sectoral variables are created. They indicate (1) the manufacturing

[1] In an alternative choice set, seven choices were generated to further differentiate between (5) Austria, (6) Czech Republic and (7) Europe/World. Results are similar when using this alternative choice set (see Table II.5 in Appendix Part II).

[2] For innovating firms that do not specify their main cooperation region in R&D, the main cooperation region of cooperation with universities and research institute is used.

Table 4.1: Firms' Main Cooperation Regions in R&D

Region	Frequency	Percentage	Cumulated Percentage
Same County	86	38.91	38.91
Lower Bavaria	45	20.36	59.27
Bavaria	42	19.00	78.27
Germany	30	13.57	91.84
Europe/World[a]	18	08.16	100.00

[a] Out of the 18 firms that mainly cooperate with international partners in R&D, two firms mainly cooperate with partners from Austria and three firms with partners from the Czech Republic.

sector, (2) the construction sector, which also includes the large regional crafts sector, and (3) the service sector. This broad sectoral classification corresponds to the division in other empirical works (for example Franco and Gussoni, 2010). With respect to firms' R&D expenditures, a binary variable is generated that indicates whether a firm devotes extra financial means to R&D.

4.3.3.3 Region-Specific Variables

The set of region-specific factors includes the geographical and institutional proximity of a region vis-à-vis Lower Bavaria. Both variables are binary coded, whereby the variable geographical proximity takes on the value one when the cooperation region is located within Lower Bavaria, and zero for the remaining alternatives. In contrast, the variable institutional proximity takes on the value one for all alternatives within Germany and zero for the alternative outside Germany. The variable can, hence, be also understood as an indicator for cooperation with national partners. Regarding the knowledge base that a region provides for a firm, a binary variable is generated that indicates whether a region hosts a relevant university or research institute, i.e. a university or research institute with which the firm cooperates. This relation may appear tautological at first glance, yet the extent to which the presence of a university or research institute within a region is a relevant factor for firms' spatial cooperation patterns can vary across firms. With respect to the functional, i.e. market importance a region has for an individual firm, two further binary variables are generated. Both indicate the function that a region fulfills within the value chain of a firm. The first variable indicates whether a region serves as a procurement market of a firm and the second one indicates whether a region

serves as a sales market of a firm. Table 4.2 provides an overview of the firm-specific and region-specific variables included in the empirical analysis.

Table 4.2: Overview over Firm-Specific and Region-Specific Variables

Firm-Specific Variables	
Size	Number of employees
Sector	1 for firms from the construction sector
	2 for firms from the manufacturing sector
	3 for firms from the service sector
R&D Expenditures	1 for firms that devote extra financial means to R&D
	0 otherwise
Region-Specific Variables	
Geographical Proximity	1 for (1) same county (2) Lower Bavaria
	0 for the remaining alternatives
Institutional Proximity	1 for (1) same county, (2) Lower Bavaria, (3) Bavaria, (4) Germany
	0 for the remaining alternative
Knowledge Base	1 if the region hosts a university with which a firm cooperates
	0 otherwise
Procurement Market	1 if the region serves as a procurement market for a firm
	0 otherwise
Sales Market	1 if the region serves as a sales market for a firm
	0 otherwise

4.4 Empirical Results

4.4.1 Firm-Specific Factors

In the first step, spatial cooperation patterns of firms in R&D are regarded as a function of firm-specific characteristics alone. The estimated results of a multinomial logit model are depicted in Table 4.3. The table entries denote relative risk ratios that are obtained from exponentiating the corresponding regression coefficients. Relative risk ratios are reported as they are more intuitive to interpret than regression coefficients in a multinomial logit model. To be precise, relative risk ratios indicate the factor change in the outcome variable relative to the reference group for one unit change in the predictor variable when all other variables in the model are kept constant (Long and Freese, 2006). In the analysis, the remainder of Germany (4), i.e. Germany except Bavaria, serves as the

reference group, which implies that the relative risk ratios of the alternative regions have to be interpreted in relation to the remainder of Germany. The remainder of Germany (4) is chosen as the reference group because it constitutes the middle category when sorting the spatial alternatives according to their geographical or institutional closeness. Hence, the three alternatives (1) same county (Landkreis), (2) Lower Bavaria and (3) Bavaria are all geographically closer to a Lower Bavarian firm than cooperation partners in the remainder of Germany. In contrast, the remaining alternative (5) Europe/World is at least institutionally further away. Relative risk ratios greater than one then indicate that firms prefer partners from a given region over partners from the remainder of Germany as their main cooperation partners in R&D. In contrast, relative risk ratios lower than one indicate that firms prefer partners from the remainder of Germany over partners from that region as their main cooperation partners in R&D. The choice of the reference category is, hence, crucial and the relative risk ratios displayed in Table 4.3 can only be interpreted in relation to the reference category. In contrast, the results do not say anything about the relation between choosing partners from the same county over partners from the remainder of Lower Bavaria, or choosing partners from Bavaria over partners from abroad. Investigating these questions requires changing the reference category. The results of the various model specifications with alternative reference groups are depicted in Tables II.6 to II.9 in the Appendix Part II. The results reveal that the findings, i.e. the relative influence of firms' size, sector and R&D expenditures, do not change when altering the reference group.

The first model specification displays regional cooperation patterns in R&D, when keeping all firm-specific factors constant. Here, results indicate that, ceteris paribus, Lower Bavarian firms prefer to cooperate with partners from the same county (Landkreis) and the same region (i.e. Lower Bavaria) over partners from the remainder of Germany. To be precise, firm are almost three times more likely to choose a partner from the same county (Landkreis) as their main partner in R&D over a partner from the remainder of Germany, and they are 1.5 times more likely to choose a partner from the same region, i.e. from Lower Bavaria, over a partner from the remainder of Germany. In contrast, firms are significantly less likely to choose partners from abroad (Europe/World) as their main cooperation partners in R&D over partners from the remainder of Germany. These findings reflect the descriptive evidence from Table 4.1 and underline that, ceteris paribus,

Table 4.3: Impact of Firm-Specific Factors on Firms' Spatial Cooperation Decisions[a]

	County/ Germany/	Lower Bavaria/ Germany/	Bavaria Germany/	Abroad Germany/
Specification I				
Constant	2.87***	1.50*	1.40	.600*
	(.609)	(.354)	(.335)	(.179)
Observations	1105			
McFadden's R^2	.001			
Specification II				
Firm Size	.998***	.999***	.999***	1.00
	(.001)	(.001)	(.001)	(.001)
Sector				
Manufac. Sector	.263***	.359**	.260***	1.26e+07
	(.089)	(.127)	(.091)	(8.13e+09)
Service Sector	.128***	.097***	.188***	.420
	(.049)	(.044)	(.076)	(484.11)
Constant	11.92***	4.58***	5.48***	7.31e-08
	(3.72)	(1.52)	(1.79)	(.001)
Observations	955			
McFadden's R^2	.061			
Specification III				
Firm Size	.999	.999	.999	1.00
	(.001)	(.001)	(.001)	(.001)
Sector				
Manufac. Sector	.547	.631	.572	7.73e+07***
	(.423)	(.517)	(.514)	(2.53e+08)
Service Sector	.486	.175	.620	3.95
	(.439)	(.199)	(.658)	(13.54)
R&D Activites	.183***	.330	.460	.541
	(.116)	(.227)	(.343)	(.462)
Constant	14.92***	5.65**	3.77*	1.58e-08***
	(9.77)	(3.97)	(2.77)	(5.52e-08)
Observations	825			
McFadden's R^2	.083			

[a] Table entries denote relative risk ratios of a multinomial logit model. Dependent variable: Main cooperation region in R&D. Reference category: Germany. Reference category sector variable: construction sector. Firm clustered standard errors in parentheses. Stars denote significance of the estimates as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

geographical and institutional proximity may indeed be relevant factors for firms' spatial cooperation patterns. The results are in line with the literature on the embeddedness of knowledge in a specific regional context, suggesting that geographic and institutional proximity are important aspects of knowledge transmission (see, for example, Asheim and Gertler, 2005; Boschma, 2005). Moreover, the results suggest that cross-border cooperation may face higher hurdles, potentially resulting from differences in the legal system and a different language and culture (Lundquist and Trippl, 2013; Trippl, 2010)[3].

[3] As Table II.5 in Appendix Part II indicates, this is true even for the geographically closer neighboring countries Austria and the Czech Republic.

When the size and the sector of a firm are included, the corresponding relative risk ratios indicate that smaller firms prefer partners from their own county (Landkreis), their own region (Lower Bavaria) or their own Federal State (Bavaria) over partners from the remainder of Germany as their main cooperation partners in R&D. This result is in line with other empirical studies suggesting that small firms may be unable or unwilling to engage in cooperation with more distant partners, as these cooperation linkages may be more costly and may require a higher absorptive capacity (see Barge-gil, 2010; Cohen and Levinthal, 1990; Veugelers, 1998). In contrast, larger firms prefer international partners over partners from the remainder of Germany. However, the corresponding relative risk ratios reveal that the positive correlation is not statistically significant.

Regarding the sector of the firm, results reveal that firms from the construction sector, which also includes the large crafts sector and which serves as the baseline category for the sectoral variables, are more likely to prefer local or regional cooperation partners, i.e. partners from their own county (Landkreis), their own region (Lower Bavaria), or their own Federal State (Bavaria) over partners from the remainder of Germany than firms from the manufacturing or service sector are. This finding suggests that for firms in this traditionally less R&D-intensive sector, the region itself is an important source of knowledge. In contrast, firms from the manufacturing sector have profoundly larger relative risk ratios in choosing international partners over partners from the remainder of Germany than firms from the construction sector do. However, the latter correlation is again not statistically significant, whereby the non-significance may be driven by the extremely large standard errors resulting from the fact that only a few Lower Bavarian firms indicate that they primarily engage in R&D-cooperate with partners from foreign regions (see Table 4.1).

In the third model specification, firms' R&D expenditures are included as a further firm-specific variable that may influence spatial cooperation patterns of firms. Results show that firms that devote extra financial means to R&D prefer cooperating with partners from the remainder of Germany over cooperating with partners from their own county (Landkreis) when controlling for firms' size and sector. This result also supports the findings of other empirical works, suggesting that R&D-prone firms require particularly analytical knowledge that may not be available in low-technology regions and that R&D-intensive firms have higher capacity to absorb analytical knowledge from interregional

partners (Asheim and Gertler, 2005). For the remaining comparisons, i.e. for the choice between Lower Bavaria or Bavarian partners and partners from the remainder of Germany as well as the choice between international partners and partners from the remainder of Germany, R&D expenditures are not statistically significant when controlling for firm size and sector. At the same time, results reveal that firm size is no longer statistically significant when controlling for R&D expenditures.

The results of the multinomial logit model provide an initial glance at the correlations between various firm-specific characteristics and firms' spatial cooperation patterns. However, in all three model specifications, the McFadden R^2, representing a measurement for the model fit in Maximum Likelihood Estimation (MLE) models, is comparatively low. Furthermore, the standard errors for the alternative outside Germany are quite high, resulting from the low number of firms choosing these regions as their main cooperation region. This suggests that the validity of the estimations is low. In the second step, the analysis is now extended and region-specific factors are assessed along with firm-specific ones. This also allows conclusions about the relative influence of both sets of factors.

4.4.2 Region-Specific Factors

To examine the relative influence of region-specific factors along with firm-specific ones, a conditional logit model is estimated. In contrast to the multinomial logit model, the conditional logit model enables the simultaneous inclusion of both firm-specific and region-specific characteristics. Table 4.4 depicts the odds ratios of the various model specifications. Similarly to the relative risk ratios in the multinomial logit model, the odds ratios of the conditional logit model are obtained by exponentiating the regression coefficients of the corresponding regression model. The odds ratios of the region-specific variables indicate the multiplicative effect of a unit change in that region-specific variable on the odds of any given spatial cooperation alternative (see Long and Freese, 2006). In the first three model specifications in Table 4.4, only region-specific characteristics are included, while the last model specification includes both region-specific and firm-specific characteristics simultaneously.

In the first model specification of the conditional logit model (Spec. 1), only the geographical and institutional proximity of an alternative cooperation region vis-à-vis Lower

Table 4.4: Impact of Region-Specific Factors on Firms' Spatial Cooperation Decisions[a]

	Spec. 1	Spec. 2	Spec. 3	Spec. 4
Geographical Proximity	1.5*	1.46*	3.88***	3.39**
	(.354)	(.345)	(1.07)	(1.89)
Institutional Proximity	2.31**	2.10**	1.69	1.59
	(.768)	(.692)	(.563)	(1.38)
University		3.22***	3.29***	3.63***
		(.962)	(.701)	(1.32)
Procurement Market			2.10***	1.99**
			(.404)	(.426)
Sales Market			3.28***	3.07***
			(.701)	(.729)
Regional Dummies	√	√	√	√
Firm-Specific Factors				√
McFadden's R^2	.206	0.226	.303	.339
Number of Observations	1547	1547	1547	1288

[a] Table entries denote odds ratios of a conditional logit regression model. Dependent variable: Main cooperation region in R&D. Firm clustered standard errors in parentheses. Stars denote significance of the estimates as follows: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Bavaria are included. Results show that both variables are statistically significant at the 0.1-significance level. The odds ratios indicate that geographic proximity increases the odds of mainly cooperating with partners from a geographically close region by a factor of 1.5. Institutional proximity even increases the odds of mainly cooperating with partners from institutionally close (i.e. domestic) regions by a factor of 2.3. These results underline that geographical and institutional proximity are indeed important aspects of firms' spatial cooperation patterns. Hence, in the region of Lower Bavaria, firms prefer cooperating with geographically close regional partners, i.e. partners from the same county (NUTS-3 region) or the same region (NUTS-2 region) in R&D. Similarly, they prefer cooperating with German partners than with foreign partners, a finding that is also obtained from the descriptive statistic in Table 4.1.

The second model specification (Spec. 2) further includes the knowledge base that a region constitutes for a firm. Whether a region constitutes an important knowledge base for a firm depends on the individual firm. In other words, a region can provide an important knowledge base for one firm, but not for another firm. As outlined above, the presence of a university or research institute with which a firm cooperates serves as an indicator for the regional knowledge base. The odds ratios from the corresponding conditional logit model show that the presence of a relevant university or research institute within a region

increases the odds of a firm mainly cooperating with partners from that region by a factor of 3.2. This result suggests that in R&D cooperation, the presence of a relevant university or research institute within the region is more influential than the region's geographical or institutional closeness of a region. These findings support the idea that university-industry linkages in R&D are important and that universities or research institutes are relevant cooperation partners for firms located in peripheral, low-technology regions, a finding that is in line with the literature (see, for example, Morgan, 1997; Benneworth and Charles, 2005; D'Este *et al.*, 2013).

In the third model specification (Spec. 3), the function that a region fulfills within the value chain of an individual firm is included as additional region-specific factor. While the first variable indicates whether a region serves as a procurement market for a firm, the second variable indicates whether a region serves as a sales market for a firm. Results reveal that both variables are statistically significant. The odds ratios show that serving as a procurement market of a firm increases the odds of firms mainly engaging in R&D cooperation with partners from that region by a factor of 2.1. Serving as a sales market even increases the odds of firms mainly engaging in cooperation with partners from that region in R&D by a factor of 3.3. These findings suggest that firms primarily engage in R&D cooperate with partners in regions that are also of functional – i.e. market – importance to them. This result may also indicate that the spatial operation radii of firms in peripheral, low-technology regions is constrained in a way that firms search for R&D cooperation partners primarily in regions that are also of functional importance to them.

In the last model specification (Spec. 4), firm-specific characteristics, precisely firms' size, sector and R&D expenditures, are included alongside the region-specific ones. None of the firm-specific factors are significant when simultaneously considering region-specific variables. In contrast, characteristics of the alternative cooperation regions remain statistically significant. These findings suggest that firm-specific characteristics can only partly explain spatial cooperation patterns of firms. Instead, region-specific factors seem to be relatively more influential.

Even though the empirical findings offer an initial glance at the correlations between firm-specific and regional-specific factors and firms' spatial cooperation patterns, some

limitations have to be noted. Firstly, the number of observations is comparably low and only few firms cooperate mainly with partners from abroad. Hence, the power of the estimations is comparatively low and the results may be driven by a few outliers, resulting in imprecise estimations. Secondly, the alternative cooperation regions vary in size and several regions (Germany, Austria, Czech Republic, Europe/World) are broad. This aggravates the interpretation of the results. Thirdly, the relations only reveal associations between firm-specific and region-specific characteristics and firms main cooperation region, but say nothing about the second or third most important cooperation regions of firms. Finally, the correlations cannot be interpreted in a causal way as the IIA assumption may not hold in the present analyses. Instead, the results can only reveal statistically significant correlations.

These correlations, however, may be of interest for regional stakeholders and policy-makers in several ways. Firstly, they suggest that regional stakeholders and policy-makers should consider region-specific factors alongside firm-specific ones when designing regional cooperation strategies. Secondly, the empirical results show that universities and research institutes are important partners for firms in peripheral, low-technology regions in the field of R&D and that strengthening university-industry linkages may indeed be an important element of regional growth and development policies. Finally, the results suggest that in order to promote inter-regional cooperation, firms should be incentivized to search for R&D partners outside their usual spatial operation radius.

4.5 Discussion and Conclusion

This essay examined spatial cooperation patterns in R&D of firms located in the German region of Lower Bavaria and evaluated the relative influence of firm-specific and region-specific factors on these spatial cooperation patterns. Empirical results, based on original micro-data of 221 regional firms, reveal that firms primarily cooperate with local or regional partners, while partners in regions outside Lower Bavaria are less frequently chosen as the main R&D cooperation partners. These findings fit well in the literature on spatial cooperation and knowledge acquisition patterns of firms, as they stress the importance of geographic and institutional proximity for knowledge spillover and the embeddedness of knowledge in a certain cultural and socioeconomic context. However,

the results also show that not all firms choose local or regional partners over partners from outside the region, indicating that firms pursue different spatial cooperation patterns.

Regarding the relative influence of firm-specific factors on firms' spatial cooperation patterns, the empirical results are in line with the literature (see Barge-gil, 2010 for an overview). Hence, they show that smaller firms are more likely to choose local or regional partners over partners from the remainder of Germany, while larger firms are more likely to cooperate with foreign partners. With respect to the sector of a firm, results show that construction firms prefer cooperating with local or regional partners than with partners from the remainder of Germany. This can be attributed to the fact that firms in this traditionally low-technology sector may lack the resources and the capacity to absorb specific, analytical knowledge from outside the region. When controlling for R&D expenditure, results show that firms which devote extra financial means to R&D prefer cooperation with interregional partners over cooperation with local or regional ones in the field of R&D. This result partially reflects the findings of other empirical works on firms' cooperation strategies in research and development, suggesting that R&D-prone firms firstly require analytical knowledge from outside the region and, secondly, have a higher absorptive capacity to benefit from inter-regional cooperation (see Asheim and Gertler, 2005 and Cohen and Levinthal, 1990).

Regarding the influence of region-specific factors, i.e. characteristics of the alternative cooperation regions, results show that along with common factors such as the region's geographic and institutional proximity, the knowledge base that a region provides for a firm and the function that a region fulfills in the value chain of a firm are equally relevant. Hence, regions that host universities or research institutes with which a firm cooperates have higher odds of being the main cooperation region of Lower Bavarian firms in R&D compared to regions that do not host such a university or research institute. This finding suggests that, in line with the literature, the presence of a university or research institute is indeed an important regional asset for a region (see, for example, D'Este *et al.*, 2013). Moreover, the results indicate that Lower Bavarian firms engage in R&D cooperation primarily with partners that are also of market importance to them. This finding suggests that the spatial operation radius of firms is limited in such a way that firms search for cooperation partners in R&D primarily in regions that serve as their procurement or sales markets. This behavior is reasonable, given the presumed bounded

rationality of firms (Simon, 1979). Yet it may hinder firms in their search for cooperation partners beyond their usual operation radius and may deter firms from cooperating with the most suitable partner. The associations between regions-specific factors and firms' spatial cooperation patterns remain statistically significant when controlling for firm-specific factors. In contrast, none of the firm-specific factors is any longer statistically significant when controlling for characteristics of the alternative cooperation regions. This finding suggests that region-specific factors are relatively more influential on firms' spatial cooperation patterns than firm-specific factors are.

Even though the analysis adds new aspects to the academic debate on firms' spatial cooperation patterns, there are some limitations to be noted. Firstly, the data are spatially and chronologically constrained, as they only include information from firms in one particular region and for one year. This cross-sectional nature inevitably limits the external validity of the results. Hence, it is not possible to control for any idiosyncratic Lower Bavarian factor or to model dynamic, path-dependent processes. Moreover, the data limitations prohibit the modeling of regional spillover effects that are commonly assessed in the literature (see, for example, Autant-Berand, 2006; Alamá-Sabater *et al.*, 2011). The small number of observations within the final sample also prohibits the estimation of more complex models such as nested logit or multinomial probit models that would relax the IIA assumption. This assumption requires that choices are independent from each other, which may not hold as some alternatives such as Lower Bavaria and Bavaria are potentially more similar to each other than others. Therefore, it is not possible to claim a causal interpretation of the associations. Instead, results can only reveal statistically significant correlations and have to be interpreted as such. A further caveat results from the fact that the alternative cooperation regions vary in size. In particular the alternatives outside Lower Bavaria are quite broad, which aggravates the interpretation of the results.

Despite these limitations, the correlations identified in this essay provide initial empirical insights into the relations between firm-specific and region-specific factors and firms' spatial cooperation patterns. In doing so, the results are a starting point for a more detailed analysis of the underlying mechanisms that can explain the rationales behind firms' spatial cooperation strategies. Knowing these rationales can provide valuable insights for regional stakeholders and policy-makers, when designing regional cooperation strategies.

Hence, the findings of this essay suggest that a sole focus on firm-specific factors may not be appropriate. Instead, region-specific patterns should also be considered. In particular, regional stakeholders and policy-makers should strengthen the regional knowledge base, which has been identified as one important region-specific factor. Furthermore, they should thoroughly analyze the market relations of regional firms, as firms tend to engage in R&D cooperation with partners in regions that are also of market importance for them. Simultaneously, they should promote interregional cooperation initiatives by incentivizing firms to search for cooperation partners outside their region. This may help firms in peripheral, low-technology regions to overcome their constrained spatial operation radius and help them to exploit knowledge from outside this radius.

Chapter 5

Spatial Cooperation Patterns and Innovation Outcomes: Lessons from Lower Bavarian Firms*

This essay examines cooperation patterns of firms in the German low-technology border region of Lower Bavaria. Particular emphasis is placed on the interplay between the spatial scale of cooperation, the form of cooperation and the type of innovation. Generic results show that overall, firms with a spatially more diverse set of cooperation linkages have a higher likelihood of innovating. However, the innovation outcomes differ depending on the spatial scale of cooperation. While cooperation with regional partners positively correlates with low-threshold innovations, cooperation with spatially distant partners positively correlates with product innovations. Surprisingly it is application-oriented cooperation that channels the relation in both cases. The findings support the view that innovation of firms in low-technology regions is driven by development rather than research. It also suggests that innovation-driven growth may even be possible in regions with limited values on the traditional innovation-supporting factors.

Keywords: Innovation, Cooperation, Low-Tech Regions, German Firms

JEL Classification: R11, O18, O31, L25

*This Chapter is joint work with Daniel Schiller and Stephan L. Thomsen and has been published in a slightly modified version in: Wassmann, P., Schiller, D. and Thomsen, S. (2016): Spatial Cooperation Patterns and their Impact on Innovation Outcomes: Lessons from Firms in a Low–Technology Region. *European Planning Studies*, 24(5):833-864. The Chapter has profited from constructive comments from the journal's editor and anonymous referees as well as from valuable feedback from participants of the Geography of Innovation Conference 2014 and the Annual Congress of the European Regional Science Association 2014.

5.1 Introduction

It is widely acknowledged that innovation is an interactive process, requiring the combination of various competencies, skills and technologies, and that firms have to acquire external knowledge in order to innovate. One main channel through which firms acquire knowledge is through cooperation with other firms, universities or research institutions. Geographic proximity is traditionally regarded as facilitating cooperation and knowledge spillovers, because of the embeddedness of knowledge in a particular sociocultural and institutional context (Breschi and Lissoni, 2009; Gertler, 2004; Malmberg and Maskell, 1999 and 2006; see Grillitsch and Nilsson, 2015 for an overview). This implies that firms located in regions with a low technological knowledge base, i.e. regions with low Research and Development (R&D) inputs and low shares of human resources in science and technology, do not profit from local cooperation in the same way as firms located in agglomeration regions with a predominance of high-technology industries (Copus and Skuras, 2006; Fragerberg, 2002). This has led some scholars to conclude that innovation-driven, economically successful development is difficult in regions that are dominated by Low and Medium-Technology (LMT) industries (see, for example, Heidenreich, 2009).

Case-specific empirical evidence, however, indicates that in some Low and Medium-Technology (LMT) regions, the majority of local firms self-report an innovative behaviour despite the limited regional knowledge base. One of these regions is the German border region of Lower-Bavaria located in the south-east corner of Germany at the German-Austrian-Czech border. In this region, two-thirds of regional firms report that they have introduced some kind of innovation between 2010 and 2013 despite the fact that the region shows comparatively low values on the traditional innovation indicators such as patents and shares of human resources in science and technology.

The literature offers two explanations for this apparent contradiction: firms in these regions may either focus on low-threshold, i.e. process or non-technological, innovation that does not require science-based, analytical knowledge (Hirsch-Kreinsen, 2008; Hirsch-Kreinsen *et al.*, 2005; Robertson and Patel, 2007), or firms may acquire innovation-relevant knowledge by cooperating with partners from outside the region (Fitjar and Rodríguez-Pose, 2011; Grillitsch and Nilsson, 2015; Varis and Littunen, 2012). While both are plausible explanations that have been empirically assessed for various peripheral

or low-technology regions, systematic empirical evidence on the interplay between the two is still comparatively scarce for the German context.

This essay examines the cooperation behaviour of firms located in the German rural, Low- and Medium-Technology (LMT) region of Lower Bavaria. It does so by building on the existing literature on the spatial dimension of cooperation (see, for example, Asheim and Gertler, 2005; Cooke, 2001) and differentiated knowledge bases (see, for example, Asheim *et al.* 2011; Jensen *et al.*, 2007; see Grillitsch and Trippl, 2013 for an overview). Lower Bavaria serves as a good case study region, because its geographical location directly at the border to Austria and the Czech Republic provides regional firms with different cooperation options within the same geographical radius. To obtain insights into the interplay between the geographic scale of cooperation, the form of cooperation and the corresponding innovation outcomes, the essay sketches the spatial cooperation patterns of firms located in Lower Bavaria with partners in the surrounding regions in Germany, Austria and the Czech Republic and differentiates between R&D-oriented cooperation (i.e. R&D cooperation with universities and research institutions) and application-oriented cooperation (i.e. procurement, sales, and production cooperation with suppliers, customers and competitors). Furthermore, it assesses the innovation outcomes that the distinct cooperation patterns entail. Here, the essay incorporates a broad innovation concept and differentiates between product innovation, process innovation and non-technological innovation (i.e. organisational innovation and marketing innovation) to account for the fact that firms in LMT regions are frequently assumed to be restrained from product innovation, but focus on lower-threshold innovation such as process or non-technological innovation (Hirsch-Kreinsen, 2008; Hirsch-Kreinsen *et al.*, 2005; Robertson and Patel, 2007). Overall, the essay addresses the following two research questions:

1. What are the spatial cooperation patterns of firms located in a LMT region?
2. How do the spatial cooperation patterns of regional firms translate into innovation success?

These questions are addressed using original micro-data from a survey of 732 Lower Bavarian firms. By examining the relation between cooperation and innovation of firms located in a successful LMT region, the findings shed light on the interplay between the

spatial scale of cooperation, the form of cooperation and the corresponding innovation outcomes. In doing so, the essay provides valuable recommendations for policymakers and regional stakeholders aiming to design public support programmes to strengthen cooperation linkages and innovativeness of firms in LMT regions.

The remainder of the essay is structured as follows: the next section provides a brief overview of the theoretical concepts and corresponding empirical evidence from the literature and states the research hypotheses. Section 5.3 sketches the main regional features of the study region. The data and the estimation strategy are described in Section 5.4. The results from the empirical analysis are reported and discussed in Section 5.5. The essay closes with a critical discussion of the main results and their implications.

5.2 Cooperation and Innovation in LMT Regions - Theoretical Background

5.2.1 Geographic Dimension of Cooperation

In recent decades, various territorial models of knowledge acquisition have been introduced, emphasising the spatial scale of cooperation. These models frequently assign the region a relevant role in the knowledge-sourcing activities of firms (Gertler, 2004; Malmberg and Maskell, 1999 and 2006). Here, the Regional Innovation System (RIS) has led the way in stressing the importance of the region for knowledge creation and knowledge diffusion between regional actors (Asheim, 1996; Asheim and Gertler, 2005; Asheim and Isaksen, 1997; Cooke, 2001; Grillitsch and Trippl, 2013). Boschma (2005) attributes the importance of local knowledge not only to geographic but also to institutional and cultural proximity that is necessary for knowledge exchange, as face-to-face contact and mutual trust support regional knowledge exchange (Boschma, 2005; Maskell and Malmberg, 2007). Other arguments underlying the importance of local knowledge spillovers refer to the tacit nature of knowledge or regional labor mobility (Breschi and Lissoni, 2009; see Grillitsch and Nillson, 2015 for an overview).

However, several empirical studies show that intra-regional cooperation is not sufficient for firms to innovate (Fitjar and Rodríguez-Pose, 2011; Grillitsch and Nillson, 2015; Varis

and Littunen, 2012). Particularly in LMT regions with a limited regional knowledge base, inter-regional cooperation is crucial in order to acquire knowledge, skills and competencies from outside the region (Iammarino, 2005; Morrison *et al.*, 2013; Tödtling *et al.*, 2011). The interrelatedness of local and global knowledge sourcing activities is also highlighted by the notion of local buzz and global pipelines introduced by Bathelt *et al.* (2004). This approach underlines the importance of the region itself, the so-called local buzz, that provides free and automatic circulation of knowledge within the region, but also stresses the importance of firms' integration into global pipelines that provide access to specific knowledge which cannot be acquired from the limited knowledge base of the region itself (Grillitsch and Trippl, 2013). Actors located in global hubs, i.e. high-technology regions that are strongly integrated into the global knowledge flows, are particularly important cooperation partners (Bathelt *et al.*, 2004).

The empirical studies that examine the cooperation behaviour of firms located in peripheral or low-technology regions support the idea that firms located in such regions have to acquire knowledge from outside the region in order to innovate. Varis and Littunen (2012), for instance, find that innovating firms perceive the importance of inter-regional cooperation with actors outside the region to be greater than non-innovating firms. In the same line, Fitjar and Rodríguez-Pose (2011) indicate that firms with cooperation linkages reaching outside the region are particularly successful in developing new products. The benefits of inter-regional networks for firms in LMT regions are also highlighted by Huggins and Johnston (2009), whose results indicate that more innovative Small and Medium-sized Enterprises (SMEs) possess denser networks with actors both within and outside the region. Further empirical evidence is provided by Lagendijk and Lorentzen (2007), who find that firms in remote regions depend heavily on non-local forms of cooperation. In the same line, Virkkala (2007) shows for a Finnish region that the leading regional firms acquire knowledge from external knowledge sources, while Vale and Caldeira (2007) illustrate for the low-technology region of Northern Portugal that the most innovative regional firms develop distant cooperation-linkages. Recent evidence from Grillitsch and Nilsson (2015) reveals that in Swedish peripheral regions, cooperation with distant partners compensates for the lack of regional knowledge spillovers.

In accordance with the literature, is is assumed is that in Lower Bavaria as one example of a rural region with a limited local knowledge base, firms have to acquire knowledge

from outside the region in order to innovate. Hence, the first hypothesis is that firms with a spatially more diverse set of cooperation linkages have a higher likelihood of innovating.

- *Hypothesis 1: The more diverse the geographic scale of cooperation is, the higher the likelihood is of firms introducing any innovation.*

Despite the empirical evidence suggesting that cooperation with spatially distant partners can be beneficial, transaction costs accompanying long distance cooperation may exceed the benefits. In the literature, this phenomenon is known as the distant decay effect, suggesting that distant cooperation is only beneficial up to a certain tipping point but that beyond this point cooperation is no longer beneficial (Crescenzi and Rodríguez-Pose, 2008; Van Beers and Zand, 2013). Cooperation with distant partners may not only be hampered by geographical distance but also by institutional and cultural distance (see Boschma, 2005). Firms entering cross-national cooperation in particular may face additional barriers originating from different customs, habits, languages and legal institutions (Lundquist and Trippl, 2013; Trippl, 2010). Given the higher transaction costs accompanying cooperation with geographically or culturally distant partners, firms may only engage in this cooperation when the required knowledge is not available from geographically closer sources. The availability of innovation-supporting knowledge on various geographical scales depends heavily on the type of knowledge that firms require and on the mode through which firms innovate. Hence, both constitute important elements for explaining the relation between the spatial scale of cooperation and innovation outcomes of firms.

5.2.2 Knowledge Bases and Modes of Innovation

Concepts that explicitly focus on the type of knowledge and the mode of innovation include the knowledge base approach (Asheim *et al.*, 2011; Asheim and Gertler, 2005) as well as the notion of Science, Technology and Innovation (STI) and the Doing, Using and Interaction (DUI) modes of innovation (Jensen *et al.*, 2007). Both approaches provide valuable starting points for an assessment of cooperation patterns and innovation behaviour of firms in low-technology regions (see Grillitsch and Trippl, 2013 for an overview).

The knowledge base approach explains firms' cooperation and innovation behaviour through different types of knowledge that firms require in order to innovate. Firms aiming to engage in product innovation are assumed to require predominantly analytical, i.e. science-based, knowledge (Asheim and Gertler, 2005; Martin and Moodysson, 2013). This form of knowledge may be best acquired from R&D-oriented cooperation with high-technology firms, universities, or research institutions (Grillitsch and Trippl, 2013). As these partners cannot be found in most rural, low-technology regions, firms have to cooperate with partners outside the region in order to introduce product innovations. In contrast, for firms aiming to introduce low-threshold innovation, i.e. process or non-technological innovation, synthetic, i.e. engineering, knowledge is more important (Grillitsch and Trippl, 2013). As synthetic knowledge is usually more tacit and less codified than analytical knowledge, geographical proximity is assumed to be more relevant for the transmission of synthetic knowledge (Grillitsch and Nillson, 2015).

Along with the type of knowledge, the mode of innovation is likewise relevant. The difference between two distinct modes of innovation, namely the Science, Technology and Innovation (STI) mode and the Doing, Using and Interaction (DUI) mode was first proposed by Jensen *et al.* (2007). Depending on the mode through which firms innovate, the cooperation behaviour of firms may vary. While firms that innovate based on a STI mode of innovation require explicit science-based, codified knowledge, firms that incorporate the DUI mode of innovation are engaged in an informal process of learning that requires experience-based knowledge exchange (Jensen *et al.*, 2007). Consequently, it is plausible that firms that incorporate the STI mode of innovation rely on R&D-oriented cooperation, whereas firms incorporating the DUI mode of innovation profit from local and regional application-oriented cooperation (Grillitsch and Trippl, 2013; Jensen *et al.*, 2007).

In summary, the literature on knowledge bases and different modes of innovation suggests that the type of knowledge and the mode of innovation are crucial elements for explaining the interplay between the spatial scale of cooperation and the corresponding innovation outcomes of firms located in a LMT region. Given the tacit nature of synthetic knowledge, cooperation with local and regional cooperation partners may be a good strategy for firms engaging in low-threshold innovations, i.e. process and non-technological innovations. In contrast, for firms engaged in product innovation that require analytical, science-based

knowledge, actors located in high-technology core regions may be suitable cooperation partners. The reason for this is that particularly in regions with a low-technology knowledge base, analytical knowledge is not available and firms are forced to engage in more costly cooperation with distant partners in order to innovate. This reasoning supports the hypothesis that cooperation on different geographical scales entails different innovation outcomes. Hence, the second hypothesis is stated as follows:

- *Hypothesis 2: Cooperation on different geographical scales entails different innovation outcomes.*
- *Hypothesis 2.1: Cooperation with local or regional partners has a positive impact on firms' likelihood of introducing low-threshold, i.e. process and non-technological, innovation.*
- *Hypothesis 2.2: Cooperation with partners in distant regions or in high-technology regions has a positive impact on firms' likelihood of introducing product innovation.*

To assess the hypotheses stated above, original micro-level data from firms located in the German rural LMT region of Lower Bavaria are used. Before introducing the empirical data, the next section sketches the main regional characteristics of Lower Bavaria in order to provide a comprehensive picture of the study region that helps to better integrate and interpret the empirical findings within the regional context.

5.3 The Regional Context of the Study Case: The Region of Lower Bavaria

As outlined above, the German region of Lower Bavaria constitutes the empirical case study area. This region represents an interesting case for economic geographers, as it has a comparatively high share of innovating firms, despite low values on the traditional innovation supporting indicators such as regional R&D expenditures, or shares of human resources in science and technology. Furthermore, its geographic location at the border to Austria and the Czech Republic provides regional firms with several spatial cooperation options within the same geographic radius (see Figure 5.1).

Figure 5.1: Map of Lower Bavaria and Surrounding Regions
Map of Lower Bavaria and the surrounding German, Austrian and Czech regions, whereby Lower Bavaria is depicted in dark coloring and Bavaria in grey coloring.

The region of Lower Bavaria qualifies as a rural region according to the official classification of the German Federal Institute for Research on Building, Urban Affairs and Spatial Development (Bundesinstitut für Bau-, Stadt-, und Raumforschung, 2014), given the lack of any major city with more than 100,000 inhabitants and the comparably low regional population density.

Politically, Lower Bavaria belongs to the Federal State of Bavaria. In terms of economic growth, Bavaria has undergone a very successful development in the past 60 years (Schiffers, 2013). While the Federal State was one of the poorest regions in West Germany after World War II, characterised by a rural and backward economic structure, Bavaria has risen since 1960 to become one of the most successful German Federal States. However, it has mainly been the metropolitan area of Munich and the surrounding region of Upper Bavaria that have profited intensely from the successful development, with multiple high-technology firms clustering around the universities and research facilities in Munich (Kujath, 2002). In contrast, Lower Bavaria, which can be perceived as a second tier region vis-à-vis Munich, has attracted far fewer high-technology firms. During the time of the Cold War, the location directly alongside the Iron Curtain was particularly disadvantageous for the region.

The regional economic structure is still characterised today by a dominance of LMT industries. When taking the sector-based classification of technology intensity proposed by the OECD (2011) as a basis, LMT industries represent over three-quarters of the regional manufacturing sector, whereas high-technology industries are absent entirely (see Table 5.1)[1].

Table 5.1: Technology Intensity of the Regional Manufacturing Industry[a]

Technology Intensity	Share of Regional Manufacturing Industries
Low-Technology Industries	35.5%
Medium-Low-Technology Industries	40.7%
Medium-High-Technology Industries	23.8%
High-Technology Industries	00.0%

[a] Share of regional manufacturing firms (by the number of establishments) by technological intensity based on the classification of the OECD Directorate for Science, Technology and Industry (2011). Own calculation based on data obtained from Industrie- und Handelskammer Niederbayern and Handwerkskammer Niederbayern-Oberpfalz (2012).

Regarding the economic structure by industry, the location of a major production subsidiary of the BMW automobile group in the region in 1969 contributed to the establishment of various suppliers, especially in the vehicle manufacturing industry. This industry still constitutes the most important regional industry and is particularly responsible for the regional growth. Between 2000 and 2012, for instance, the turnover of the German automobile industry and the regional gross domestic product (GDP) strongly correlated. However, the regional automobile industry is mainly production-driven, while research only plays a subordinate role in the region and mainly takes place at the BMW headquarters in Munich. Hence, innovation may, if at all, be driven by incremental process improvements facilitated by cooperation with suppliers. Along with the automobile industry, the engine building and plant construction industries are also quite strong in the region. Both industries classify as medium-technology industries according to the official OECD classification outlined above. Given their medium technology intensity, both industries are assumed to innovate based on a DUI mode of innovation, requiring particularly engineering-based, synthetic knowledge. Hence, in these industries, development seems to be more important than research and firms may introduce particularly low-threshold innovations, i.e. process and non-technological innovations. With respect

[1] This sector-based distinction is not indisputable (see, for example, Kirner *et al.*, 2009).

to firm size, small and medium-sized enterprises (SME) dominate, a pattern that can be observed in many rural, low-technology regions.

In summary, the region of Lower Bavaria is certainly disadvantaged by its low-technology industrial structure and the limited regional knowledge base. However, two-thirds of regional firms have introduced some form of innovation between 2010 and 2013 and the economic performance indicators such as regional per capita GDP and employment are well above the German average. Given these apparently contradicting regional features, Lower Bavaria serves as a good example of a specific type of European region that is quite successful despite a limited regional knowledge base and low levels of regional R&D.

5.4 Data and Variables

5.4.1 Data

To assess the spatial cooperation patterns of regional firms and their impact on innovation outputs, original micro-level data from a survey of Lower Bavarian firms conducted between February and April 2013 are used[2]. The advantage of the data compared to standard innovation surveys (for example the Community Innovation Survey) is that they provide detailed information on the spatial scale of cooperation and the form of cooperation. On the output side, the data allow a distinction between product innovation, process innovation and non-technological innovation, i.e. organisational and marketing innovations. This enables a nuanced assessment of the interplay between these three dimensions. The broad innovation concept is especially crucial, because firms operating in LMT industries are frequently assumed to innovate through low-threshold innovations. The drawback, however, is that these precise data are only available for Lower Bavarian firms. Hence, it is not possible in this essay to compare the results of Lower Bavarian firms with the cooperation patterns and innovation outcomes of firms located in other regions. Nevertheless, the analysis provides a valuable descriptive starting point for exploring the interplay between cooperation and innovation of firms located in a LMT region.

[2]As outlined above, the data have been compiled in the course of a joint research project of the Lower Saxony Institute of Economic Research, the Lower-Bavarian Chamber of Commerce and the Chamber of Handicrafts of Lower Bavaria and Upper Palatinate. The German version of the questionaire used in the firm survey is included in Appendix Part II (II.1).

The sample of firms is drawn from the firm database of the regional Chamber of Commerce and Industry (Industrie- und Handelskammer Niederbayern) and the regional Chamber of Handicrafts (Handwerkskammer Niederbayern-Oberpfalz). Due to the compulsory membership of German firms in one of the two chambers, the joint database can be considered as comprehensive. Overall, 5,347 firms were asked to participate in the survey, reflecting all regional firms with an annual turnover of more than 17,500 Euro. This boundary was implemented to exclude the large number of micro-firms, which would potentially bias the results due to non-cooperation. In the survey, firms were contacted either by email or post. Overall, 732 Lower Bavarian firms participated in the survey, reflecting a return rate of 13.7%. Even though this return rate is quite low, its scale is similar to response rates in comparable firm surveys. Hence, even in the more institutionalised Community Innovation Survey, the response rate for German firms does not exceed 20% (Zentrum für Europäische Wirtschaftsforschung, 2011). However, due to item-non response, only 399 firms (i.e. 7.46%) are included in the subsequent analysis. However, the results of an item-response analysis confirm that the 399 firms included in the final sample do not significantly differ from firms, for which only limited information is available (see Table II.4 in Appendix Part II).

As Table 5.2 depicts, the sample of firms includes not only manufacturing firms, but also firms from the construction sector and the service sector. This may appear unusual, because the innovation behaviour of these firms differs greatly from that of manufacturing firms (see, for example, Hipp and Grupp, 2005). The empirical analysis, nevertheless, includes all firms in the sample, because the goal of the essay is to obtain a thoughtful picture of the cooperation patterns and their innovation implications for all firms in the region. Thereby, it is assumed that even though innovation differs between the manufacturing sector, the service sector and the construction sector, innovative firms behave differently in all three sectors than non-innovative firms when it comes to cooperation. Since innovation behaviour is self-reported, it is interesting to compare the cooperation behaviour of firms that regard themselves as innovative and firms that do not. Still, the empirical analysis accounts for the fact that the innovation behaviour of firms from the service or construction sector may systematically differ from that of manufacturing firms. It does so by including sector dummies in the estimation model and by conducting a separate analysis for the sub-sample of manufacturing firms. Results stay the same when

only considering a sample of manufacturing firms (see Tables II.10 to II.17 in Appendix Part II).

With respect to the distribution of firms by size and sector, it becomes evident that small firms with fewer than 50 employees dominate, a pattern that reflects the actual distribution of Lower Bavarian firms. The results of several representativity tests confirm that firms included in the final sample are representative for the entire population of regional firms with respect to its size and its location within the regional districts of Lower Bavaria (see Tables II.1 to II.3 in Appendix Part II).

Table 5.2: Distribution of Firms in the Sample According to Size and Sector[a]

	Firm Size (Number of Employees)						
Sector	<10	<50	<100	<250	<1000	≥ 1000	
Construction Sector	56	43	10	2	1	1	113
Manufacturing Sector	81	75	21	22	14	4	217
Service Sector	31	33	4	0	1	0	69
	168	151	35	24	16	5	399

[a] Distribution of Lower Bavarian firms according to size and sector. Own calculation.

5.4.2 Variables

5.4.2.1 Explanatory Variable: Cooperation

With respect to firms' cooperation patterns, the essay examines the spatial scale of firms' cooperation according to the form of cooperation. It does so by asking firms to indicate their cooperation linkages in a two-dimensional matrix. The first dimension, i.e. the spatial dimension, includes the geographic distribution of cooperation linkages. In this dimension, firms could choose from a list of 26 different regions in which their cooperation linkages are geographically located. The second dimension includes the form of cooperation, i.e. procurement cooperation, production cooperation, sales cooperation, R&D cooperation and employee training cooperation, and the cooperation partner, i.e. suppliers, customers, competitors, universities and research institutes (see the questionnaire in Appendix Part II.1).

For the subsequent analysis, the information obtained from this cooperation matrix is aggregated to various binary cooperation variables indicating the spatial scale and the form of cooperation. This allows a fine-grained assessment of the spatial cooperation patterns of regional firms and the relation between the various cooperation patterns and their innovation implications. Regarding the spatial scale, binary variables for cooperation with partners in Lower Bavaria, Bavaria (excluding Lower Bavaria) and Germany (excluding Bavaria) are generated. This enables examining the relation between cooperation and innovation on different spatial scales. Further binary variables include a variable for cooperation with partners in Munich, the nearby high-technology region, and variables for cross-border cooperation with partners in Austria and in the Czech Republic, as well as for cooperating with partners in distant regions, i.e. with partners from regions outside Germany, Austria and the Czech Republic. This differentiation allows assessing whether cooperation with distant partners or with partners in high-technology regions correlates with the introduction of product innovations that presumably require analytical knowledge that may not be present within the region. Moreover a variable that indicates the geographical scope of cooperation, i.e. the number of different regions with which a firm cooperates, is created. This allows examining whether a spatially more diverse scope of cooperation is positively correlated with a higher likelihood of a firm innovating. The variable takes on values between 0 and 7, depending on the number of different regions with which a firm cooperates.

Along with the spatial scale of cooperation, the form of cooperation is also important, as it may serve as an intermediate, channeling the relation between the spatial scale of cooperation and innovation outcomes of firms. Drawing from the literature on knowledge bases and different modes of innovation (see, for example, Asheim *et al.*, 2011; Asheim and Gertler, 2005; Jensen *et al.*, 2007), it is expected that application-oriented cooperation is beneficial for low-threshold innovations, i.e. process innovation and non-technological innovations, while R&D-oriented cooperation should stimulate product innovation in particular. To account for the fact that the form of cooperation may drive the relation between the spatial scale of cooperation and the type of innovation output of firms, a variable for R&D-oriented cooperation and a variable for application-oriented cooperation are generated for every spatial dimension identified above. While the former includes explicit R&D cooperation and cooperation with universities and research

institutions, application-oriented cooperation includes procurement cooperation, sales cooperation and production cooperation, as well as cooperation with suppliers, customers and competitors[3]. Hence, for every geographical scale, three cooperation variables are observed: one for R&D-oriented cooperation, one for application-oriented cooperation, and one for an aggregate of the two. Overall, 21 (7x3) binary cooperation variables are generated.

5.4.2.2 Dependent Variable: Innovation

With respect to innovation, the essay applies a broad innovation concept to account for the fact that innovation of firms in low-technology regions is frequently assumed to be based on low-threshold innovation, i.e. process or non-technological innovation (Hirsch-Kreinsen, 2008; Hirsch-Kreinsen *et al.*, 2005; Robertson and Patel, 2007). This definition of innovation follows the guidelines for interpreting innovation data outlined by the OECD and Eurostat in the Oslo Manual (OECD and Eurostat, 2005). In the survey, therefore, firms were asked to differentiate between product innovation, process innovation, organisational innovation and marketing innovation. A detailed description of the wording used in the corresponding questionnaire (in German) is given in Appendix II.1. In line with the suggestions of the OSLO Manual and other empirical works (see, for example, Pippel, 2014), marketing innovation and organisational innovation are aggregated to non-technological innovation. The differentiation between product, process and non-technological innovations allows examining how the various cooperation patterns of firms in low-technology regions translate into different types of innovations.

The descriptive statistics of firms' innovation outputs are depicted in Table 5.3. The statistics reveal that 60.4% of Lower Bavarian firms have introduced some form of innovation, i.e. product, process, or non-technological innovation, between 2010 and 2013. This is lower than the German average, which amounted to 87% in 2008, but higher than the average in all other EU countries except Austria, Belgium and Luxembourg (Rammer and Pesau, 2011). With respect to technological innovation, i.e. product and

[3]Admittedly, cooperation with competitors seems strange at first, but empirical evidence has shown that firms frequently cooperate with competitors to form strategic alliances and gain access to knowledge resources and capabilities (see, for example, Haeussler *et al.*, 2012). Moreover, firms may choose competitors as cooperation partners, because by cooperating with local or regional competitors, they can establish and exploit cluster effects, i.e. a combination of cooperation and competition (Porter, 2000).

process innovation, and non-technological innovations, results indicate that the share of firms that have introduced technological innovations is slightly higher than the share of firms that have introduced non-technological innovations, i.e. marketing innovations or organisational innovations between 2010 and 2013. This is despite the fact that the region's characteristics would suggest that low-threshold innovations, i.e. process and non-technological innovations, prevail. Hence, regional firms may indeed be able to introduce product innovation, because they acquire the necessary knowledge through cooperation. Moreover, in line with other firm surveys, innovation behaviour is self-reported. As multiple answers were possible, the categories, i.e. product innovations, process innovations and non-technological innovations are not mutually exclusive.

Table 5.3: Innovation in Lower Bavaria[a]

	Yes		No		n
1. Technological Innovation	178	(44.61%)	221	(55.39%)	399
1.1 Product Innovation	148	(37.09%)	251	(62.91%)	399
1.2 Process Innovation	76	(19.05%)	323	(80.95%)	399
2. Non-Technological Innovation	164	(41.10%)	235	(58.90%)	399
3. Any Innovation	241	(60.40%)	158	(39.60%)	399

[a] Number and share (in parantheses) of Lower Bavarian firms that have or have not introduced product, process, non-technological or any innovation between 2010 and 2013.

5.4.2.3 Control Variables: Innovation-Supporting Variables

To control for certain firm-specific characteristics when assessing the impact of the different cooperation patterns on innovation, a parsimonious set of control variables is included in the analysis. The control variables are chosen in accordance with the factors that have been identified in the literature as potentially influencing the relationship between cooperation and innovation in LMT regions (Barge-gil, 2010). The set comprises the size and the sector of a firm as well as a firm's R&D expenditure, which have been shown to affect firms' likelihood of innovating in regions with a low-technology industrial structure[4]. The size of a firm is measured by the number of employees. The variable is categorical, with

[4]The literature suggests that the size of a firm and firms' R&D expenditure both have a positive effect; regarding the sector, export-oriented industries and high-technology industries in particular positively affect firms' likelihood of innovating (Barge-gil, 2010). A further variable frequently mentioned is the presence of a distinct R&D department. However, as this variable highly correlates with R&D expenditure, it is not included in the analysis.

categories approximating the common EU classification (European Commission, 2006)[5]. Results do not change significantly when using the annual turnover to determine the size of a firm. With respect to the sector, three binary sectoral variables are created. They indicate (1) the manufacturing sector, (2) the construction sector, which also includes the large regional crafts sector, and (3) the service sector[6]. Regarding firms' initial R&D inputs, a binary variable indicating whether or not a firm devotes financial means to R&D is generated, constituting a proxy for a firm's in-house capacity. By and large, about a quarter of Lower Bavarian firms use financial means for R&D.

5.5 Empirical Results

5.5.1 Spatial Cooperation Patterns of Firms in a LMT Region

The empirical assessment begins with a descriptive analysis of the spatial cooperation patterns of Lower Bavarian firms, differentiating between R&D-oriented and application-oriented cooperation. The cooperation patterns displayed in Tables 5.4 and 5.5 show that local cooperation, i.e. cooperation with Lower Bavarian partners, and regional cooperation, i.e. cooperation with Bavarian partners, prevail across both forms of cooperation. This finding is in line with the literature on the nature of knowledge exchange, suggesting that geographic proximity is indeed a relevant aspect (Breschi and Lissoni, 2009; Gertler, 2004; Malmberg and Maskell, 2006). Firms located in low-technology regions seem to generate and exploit regional agglomeration effects. Munich, the nearest core region, is also an important partner when it comes to application-oriented cooperation. In contrast to what is expected from the literature, however, it is not R&D-oriented cooperation that prevails when cooperating with partners in Munich.

Comparing the descriptive results to the German average as depicted in the Community Innovation Survey (Zentrum für Europäische Wirtschaftsforschung, 2014), the findings reveal that Lower Bavarian firms are more often engaged in application-oriented cooperation, i.e. cooperation with customers, suppliers and competitors, than the German

[5]In the analysis, the following thresholds are applied: (0) 0 employees, (1) 1-9 employees, (2) 10-49 employees, (3) 50-99 employees, (4) 100-249 employees, (5) 250-999 employees, (6) more than 1000 employees.

[6]Here, the sector is based on self-indication of firms and may deviate from the classification reported in the official statistics.

Table 5.4: Firms' Spatial Cooperation Patterns by Functional Form of Cooperation[a]

	R&D Cooperation	Procurement Cooperation	Sales Cooperation	Production Cooperation	Training Cooperation
	R&D cooperation	*Application-oriented cooperation*			
Lower Bavaria	9.27%	28.07%	24.81%	24.31%	18.55%
Munich	2.01%	6.02%	6.52%	3.01%	1.50%
Bavaria	6.02%	13.78%	14.04%	9.52%	5.26%
Germany	7.02%	10.53%	8.77%	4.26%	2.51%
Austria	1.75%	5.01%	5.26%	4.26%	0.25%
Czech Republic	0.00%	2.01%	2.76%	2.76%	0.25%
Distant Regions	2.26%	5.75%	6.52%	4.26%	1.25%

[a] Percentage of cooperation linkages by spatial scope and functional form (N=399).

Table 5.5: Firms' Spatial Cooperation Patterns by Cooperation Partner[a]

	Universities	Suppliers	Customers	Competitors
	R&D cooperation	*Application-oriented cooperation*		
Lower Bavaria	12.03%	31.83%	35.59%	15.04%
Munich	3.01%	5.01%	9.02%	2.26%
Bavaria	5.76%	15.79%	19.05%	19.30%
Germany	4.26%	11.53%	11.28%	3.76%
Austria	0.75%	6.02%	5.51%	1.50%
Czech Republic	0.00%	2.26%	2.51%	0.50%
Distant Regions	0.75%	5.01%	6.27%	3.51%

[a] Percentage of cooperation linkages by spatial scope and partner (N=399).

average. At the same time, they are less frequently engaged in R&D-oriented cooperation, i.e. in cooperation with universities or research institutes. These findings are in line with the presumption that firms located in LMT regions require primarily synthetic, engineering-based knowledge and innovate primarily via the DUI mode of innovation (Jensen *et al.*, 2007).

With regard to cross-border cooperation, results show that Lower Bavarian firms cooperate more with partners from Austria than with partners from the Czech Republic, despite the fact that both countries are located within the same geographic radius. This suggests that cultural and institutional proximity may indeed be important when engaging in cross-border cooperation (see Lundquist and Trippl, 2013; Trippl, 2010). Moreover, firms may profit particularly from technologically more advanced Austrian partners.

5.5.2 Impact of Spatial Cooperation Patterns on Innovation Outcomes

The description of the cooperation patterns outlined above provides an initial overview of the cooperation behaviour of firms in a LMT region. However, the results do not yet tell anything about the extent to which cooperation translates into innovation success. Therefore, the empirical analysis now turns to the impact of cooperation on innovation.

To empirically investigate the impact of cooperation on innovation – while controlling for different firm-specific confounding factors – a binary regression model with various specifications is estimated. The likelihood of a firm innovating is thereby regressed on the various cooperation variables, on the size and the sector of the firm and on the firm's R&D inputs. The baseline model can be described as follows:

$$P(innov_i = 1) = \alpha_i + \beta_1(C_i) + \beta_2(S_i) + \beta_3(B_i) + \beta 4(RD_i) + \epsilon_i,$$

where $innov_i$ refers either to product innovation, process innovation or non-technological innovation, i.e. marketing or organisational innovations, i denotes the specific firm and α_i the intercept for each firm i. The parameters β_1 to β_4 denote the estimated parameters for the independent variables included in the model. Here, C_i depicts the various binary cooperation variables, or, alternatively, the geographic scope of cooperation of firm i. S_i depicts the firm size, measured by the number of employees. B_i denotes the firm's branch, i.e. sector, included as various sectoral binary variables with the service sector serving as the reference category, and RD_i denotes firms' financial R&D inputs. Finally, ϵ_i denotes the error term.

5.5.2.1 Spatial Scope of Cooperation

The analysis begins with regressing the likelihood of firms innovating on their geographic scope of cooperation. This allows testing the first presumption, namely that firms with a spatially more diverse set of cooperation partners have a higher likelihood of innovating. Figure 5.2 displays the predicted probabilities of firms introducing any innovation dependent on the geographic scope of cooperation, i.e. the number of different regions

with which a firm cooperates. Results show that the probability of firms innovating significantly increases with the number of different regions with which a firm cooperates. Results are similar when distinguishing between R&D-oriented cooperation and application-oriented cooperation.

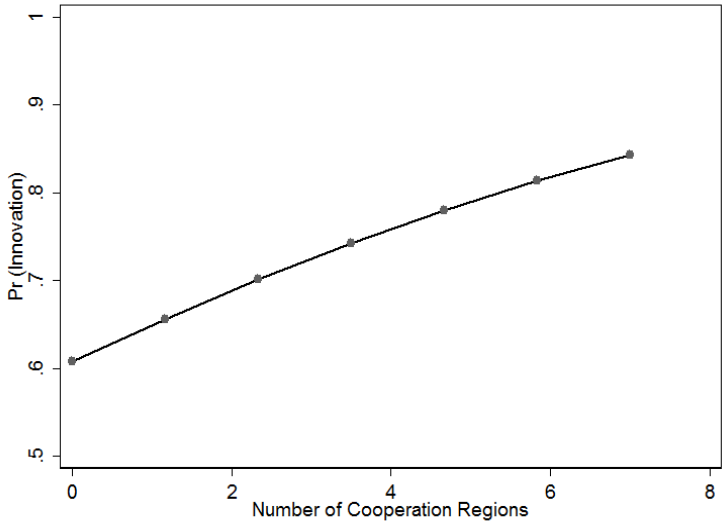


Figure 5.2: Scope of Cooperation and Firms' Likelihood of Innovating

Overall, the result supports the first hypothesis, namely that firms cooperating with a spatially more diverse set of partners have a higher likelihood of innovating, even when controlling for the size and sector of the firm as well as for firms' R&D expenditures. This suggests that regional cooperation alone is not sufficient for stimulating innovation. Instead, the interplay between both regional and inter-regional cooperation is important. This is in line with the literature on Regional Innovation Systems (RIS) and the notion of local buzz and global pipelines, which both highlight the importance of the interplay between local and global knowledge-sourcing activities (see, for example, Asheim, 1996; Asheim and Gertler, 2005; Bathelt *et al.*, 2004).

5.5.2.2 Cooperation Patterns and Innovation Outcomes

While the previous finding shows that firms with a spatially more diverse set of cooperation partners have a higher likelihood of innovating, the result does not provide any conclusion on the impact of cooperation on different geographical scales. To shed more light on the relation between cooperation and innovation at various spatial scales,

the essay now assesses the relation between cooperation and innovation separately for each geographical scale. It further differentiates between R&D-oriented and application-oriented cooperation to examine the extent to which the form of cooperation influences the relation between the spatial scale of cooperation and innovation.

Figure 5.3 reports the average marginal effects of the different cooperation variables on the likelihood of firms introducing any innovation, including product, process, or non-technological innovation. The marginal effects are calculated based on the estimated results of the logistic regression model spelled out above. To be precise, they are calculated by computing the marginal effect of a distinct independent variable for each firm individually, and then calculating the average over all firms. Marginal effects instead of the regression coefficients are presented, because the latter are difficult to interpret when applying logistic regression. Moreover, marginal effects provide a good approximation for the amount of change in the dependent variable that is produced by a unit change of the independent variable (William, 2012). As the cooperation variables are binary variables, the marginal effects do, however, not reflect the effect of an instantaneous change of the independent variable, but rather the effect of a discrete change from 0 to 1. The results show that cooperation positively relates to innovation on all spatial scales, except for cooperation with partners in the Czech Republic and R&D-cooperation with distant partners. The negative effect for cooperation with Czech partners might indicate that cooperation with partners in the Czech Republic is not innovation-driven. However, it is highly plausible that firms cooperating with partners in the Czech Republic instead primarily exploit price advantages. The positive relation is statistically significant only for cooperation with partners in Bavaria and Austria when controlling for the size and sector of the firm as well as for the firm's R&D expenditures. For cooperation with partners in Bavaria, the average marginal effect amounts to .118 for all cooperation, i.e. R&D or application-oriented cooperation. This means that on average, firms that maintain cooperation-linkages with partners from Bavaria have a 11.8 percentage points higher probability of innovating than otherwise similar firms that do not cooperate with partners in Bavaria. The marginal effect of cooperating with partners from Austria is even larger, amounting to 17.2 percentage points. As evident from the values in Figure 5.3 application-oriented cooperation drives the statistically significant relation in both regions. This suggests that in line with the literature, in this region, it is synthetic,

application-oriented knowledge that is transmitted through these cooperation linkages.

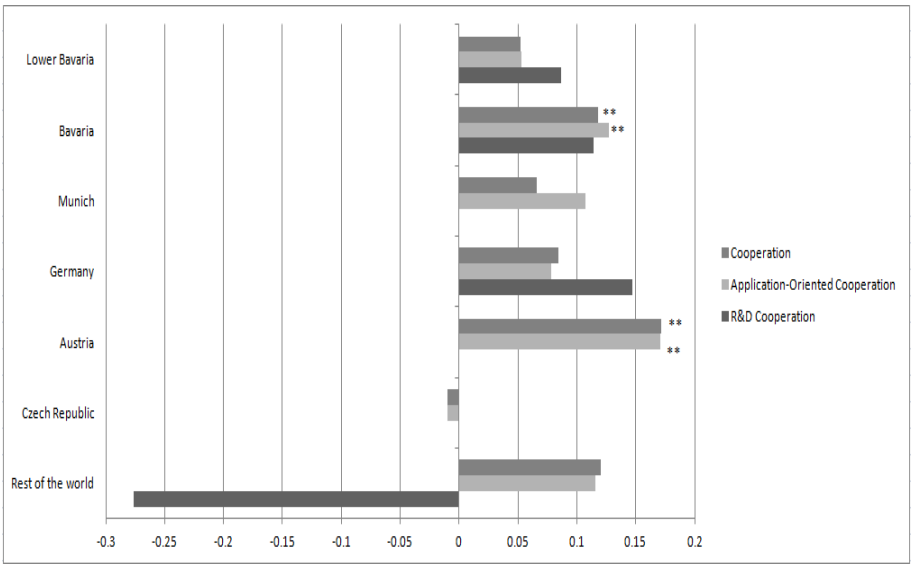


Figure 5.3: Average Marginal Effects of Cooperation on Innovation
$^{*}p < .10$; $^{**}p < .05$; $^{***}p < .01$.

Regarding the control variables, R&D expenditure and the number of employees reveal a statistically significant positive average marginal effect (see Table 5.6 and 5.7). In accordance with other studies (see Barge-gil, 2010 for an overview), this means that large firms and firms that devote extra financial means to R&D have a higher likelihood of innovating. In contrast, the sector has no significant effect in the region of Lower Bavaria. The marginal effects of the sectoral variables are not statistically significant. This indicates that whether a firm belongs to the manufacturing sector or to the construction sector, rather than to the service sector that serves as the reference group in the estimation model, does not significantly change the firm's probability of innovating when all other firm characteristics, i.e. cooperation patterns, size, R&D expenditures, are similar.

Table 5.6: Impact of Various Cooperation Patterns on Innovation: National Partners[a]

	Lower Bavaria			Bavaria			Munich			Germany		
	all	RD	Appl	all	RD	Appl	all	RD	Appl	all	RD	Appl
Cooperation	.052	.087	.053	.118**	.114	.127**	.066	O	.107	.084	.147	.078
	(1.19)	(1.02)	(1.21)	(2.74)	(1.10)	(2.94)	(1.54)	(.)	(1.85)	(1.44)	(0.96)	(1.31)
Firm Size	.063**	.058*	.063**	.060*	.058*	.062**	.063**	.061*	.060*	.060*	.060*	.060*
	(2.60)	(2.40)	(2.63)	(2.54)	(2.41)	(2.60)	(2.62)	(2.53)	(2.49)	(2.48)	(2.51)	(2.51)
R&D Contribution	.529***	.508***	.533***	.513***	.517***	.518***	.528***	.533***	.528***	.509***	.507***	.516***
	(6.91)	(6.35)	(6.99)	(6.74)	(6.64)	(6.87)	(6.93)	(6.94)	(6.93)	(6.48)	(6.34)	(6.63)
Manu. Sector	.082	.077	.081	.084	.080	.084	.081	.079	.079	.070	.079	.071
	(1.72)	(1.63)	(1.72)	(1.78)	(1.68)	(1.79)	(1.71)	(1.67)	(1.67)	(1.46)	(1.66)	(1.48)
Service Sector	-.012	-.020	-.012	-.022	-.020	-.020	-.011	-.020	-.019	-.035	-.023	-.031
	(-.190)	(-.320)	(-.180)	(-.340)	(-.310)	(-.320)	(-.180)	(-.320)	(-.300)	(-.540)	(-.350)	(-.490)
Observations	399	399	399	399	399	399	399	399	399	399	399	399
McFadden's R^2	.21	.21	.21	.22	.21	.23	.22	.21	.22	.21	.21	.21

[a] Table entries denote average marginal effects of various cooperation patterns (columns) on innovation. Dependent variables: Innovation (any type of innovation). Reference category for sectoral variables: construction sector. T statistics in parentheses. Stars denote significance of the estimates as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5.7: Impact of Various Cooperation Patterns on Innovation: International Partners[a]

	Austria			Czech Republic			Distant Partners		
	all	RD	Appl	all	RD	Appl	all	RD	Appl
Cooperation	.172**	O	.171**	-.010	O	-.010	.120	-.276	.116
	(2.64)	(.)	(2.63)	(-.100)	(.)	(-.100)	(1.31)	(-1.41)	(1.26)
Firm Size	.062*	.062*	.062	.061*	.061*	.061*	.060*	.061*	.060*
	(2.57)	(2.54)	(2.58)	(2.53)	(2.53)	(2.53)	(2.46)	(2.54)	(2.45)
R&D Contribution	.523***	.527***	.523***	.533***	0.533***	.533***	.512***	.567***	.515***
	(6.92)	(6.67)	(6.93)	(6.94)	(6.94)	(6.94)	(6.55)	(6.59)	(6.61)
Manufacturing Sector	.057	.081	.057	.079	.079	.079	.074	.077	.074
	(1.19)	(1.68)	(1.19)	(1.67)	(1.67)	(1.67)	(1.55)	(1.63)	(1.55)
Service Sector	-.049	-.024	-.049	-.020	-.020	-.020	-.032	-.020	-.031
	(-.760)	(-.370)	(-.760)	(-.320)	(-.320)	(-.320)	(-.500)	(-.310)	(-.490)
Observations	399	399	399	399	399	399	399	399	399
McFadden's R^2	.22	.20	.22	.21	.21	.21	.21	.21	.21

[a] Table entries denote average marginal effects of various cooperation patterns (columns) on innovation. Dependent variables: Innovation (any type of innovation). Reference category for sectoral variables: construction sector. T statistics in parentheses. Stars denote significance of the estimates as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

To evaluate the performance of the various model specifications, the McFadden R^2 is used as our goodness-of-fit measurement (see Tables 5.6 to 5.13). The McFadden R^2 has been proven as a valid measurement for the model fit in Maximum Likelihood Estimation (MLE), even though the McFadden R^2 is smaller than the R^2 in Ordinary Least Squares (OLS) regression models (Allison, 2012). It is evident that the McFadden R^2 ranges between 0.19 and 0.23, pointing towards a satisfying goodness-of-fit of the first set of model specifications.

While in the first set of models specifications the aggregated innovation variable constitutes the dependent variable, in the following section, the various model specifications are estimated separately for product innovation, process innovation and non-technological innovations. With respect to product innovations, the corresponding average marginal effects for cooperation, calculated from the estimated coefficients of the logistic regression model are depicted in Figure 5.4. Results show that cooperation on most geographical scales has a positive effect on the likelihood of firms introducing product innovations. As the results show, the cooperation variable is only statistically significant in the case of cooperation with distant partners, i.e. partners in regions other than Germany, Austria and the Czech Republic. Firms cooperating with distant partners have a 16.6 percentage points higher probability of introducing a product innovation than otherwise similar firms that do not maintain cooperation-linkages with distant partners. This result is in line with the presumption that cooperation with partners in distant regions has a positive impact on firms' likelihood of introducing product innovation. This indicates that firms exploit analytical knowledge when innovating with geographically distant cooperation partners. However, in contrast to the expectations from the literature, it is not R&D-oriented cooperation that channels the relation, but rather application-oriented cooperation that matters.

When it comes to process innovation (see Figure 5.5), the average marginal effects are by and large negative, except for cooperation with local, i.e. Lower Bavarian partners although they are not statistically significant. The results may be driven by the comparatively limited number of firms that have introduced process innovations in the past three years. Hence, the validity of the results for process innovation as the dependent variable is rather weak, which is also indicated by the comparatively low McFadden R^2 (see Table 5.10 and 5.11). For non-technological innovations, the goodness-of-fit is also quite low

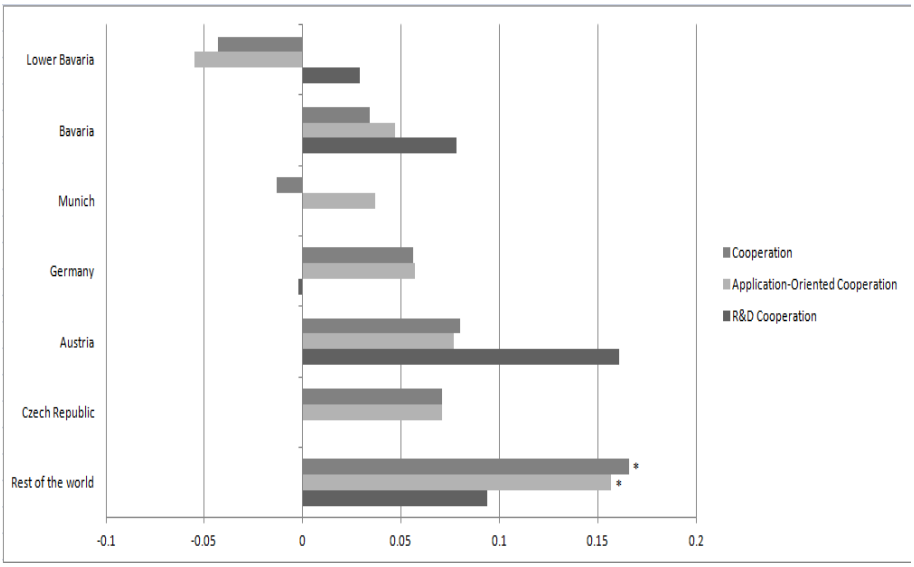


Figure 5.4: Average Marginal Effects of Cooperation on Product Innovation
$^{*}p < .10$; $^{**}p < .05$; $^{***}p < .01$.

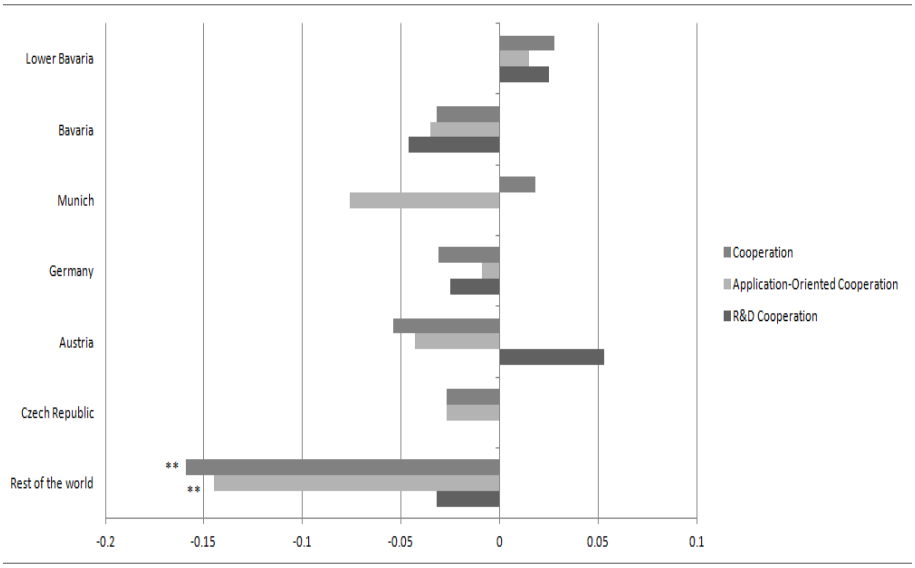


Figure 5.5: Average Marginal Effects of Cooperation on Process Innovation
$^{*}p < .10$; $^{**}p < .05$; $^{***}p < .01$.

(see Table 5.12 and 5.13). In this set of model specifications, however, a positive, statistically significant average marginal effect is still observable for cooperation with regional, i.e. Lower Bavarian and Bavarian, partners (Figure 5.6). Hence, firms that maintain cooperation linkages with Bavarian partners have a 12.2 percentage points higher probability of introducing non-technological innovations than otherwise similar firms that do not cooperate with partners from Bavaria. This finding is in line with the hypothesis that cooperation with local or regional partners has a positive effect on firms' likelihood

of introducing low-threshold innovations. As evident from the reported average marginal effects in Figure 5.6, it is again application-oriented cooperation that drives the relation, a finding that is in line with expecations from the literature.

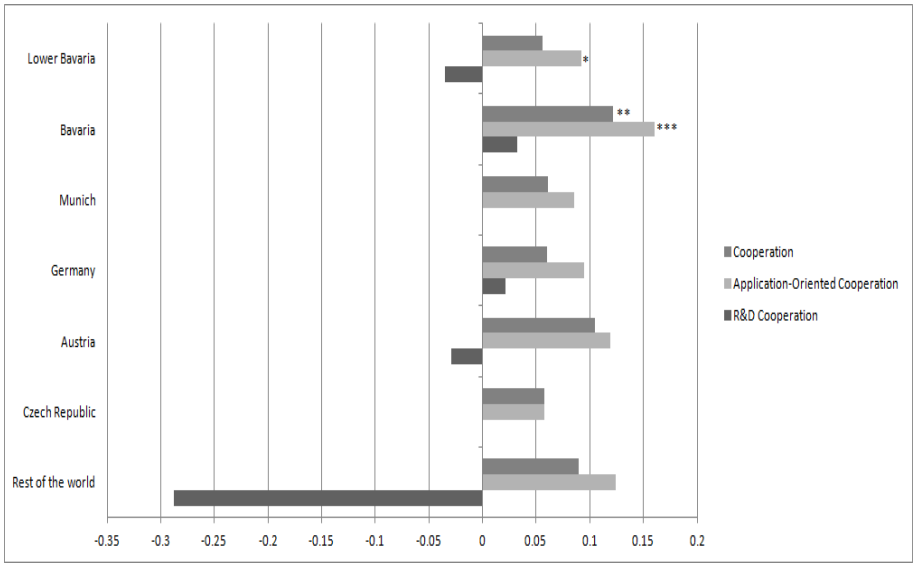


Figure 5.6: Average Marginal Effects of Cooperation on Non-Technological Innovation
$^{*}p < .10$; $^{**}p < .05$; $^{***}p < .01$.

Results also show that on all other spatial scales the cooperation variables are not statistically significant, irrespective of the form of cooperation and the type of innovation. This is, of course, not to say that firms cooperating with partners in these regions do not innovate. However, cooperation with partners in these regions does not affect the innovation behaviour of the firm when keeping the control variables constant.

Table 5.8: Impact of Various Cooperation Patterns on Product Innovation: National Partners[a]

	Lower Bavaria			Bavaria			Munich			Germany		
	all	RD	Appl	all	RD	Appl	all	RD	Appl	all	RD	Appl
Cooperation	-.043	.029	-.055	.034	.078	.047	-.013	O	.037	.056	-.002	.057
	(-1.02)	(.47)	(-1.33)	(.800)	(1.06)	(1.09)	(-.310)	(.)	(.670)	(1.13)	(-.030)	(1.14)
Firm Size	.024	.022	.023	.024	.021	.024	-.310	.024	.024	.022	.024	.023
	(1.23)	(1.14)	(1.20)	(1.23)	(1.06)	(1.28)	(1.23)	(1.23)	(1.22)	(1.14)	(1.23)	(1.19)
R&D Contribution	.377***	.366***	.373***	.370***	.363***	.371***	.375***	.374***	.374***	0.358***	0.375***	0.362***
	(10.90)	(9.36)	(10.77)	(10.56)	(10.01)	(10.71)	(10.85)	(10.85)	(10.83)	(9.56)	(9.67)	(9.92)
Manufacturing Sector	.076	.077	.075	.081	.081	.081	.078	.079	.079	.074	.079	.073
	(1.49)	(1.52)	(1.47)	(1.59)	(1.59)	(1.60)	(1.53)	(1.54)	(1.54)	(1.44)	(1.54)	(1.42)
Service Sector	.021	.025	.020	.026	.026	.027	.025	.026	.026	.017	.026	.020
	(.310)	(.380)	(.300)	(.400)	(.400)	(.400)	(.380)	(.390)	(.400)	(.260)	(.390)	(.310)
Observations	399	399	399	399	399	399	399	399	399	399	399	399
McFadden's R^2	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20

[a] Table entries denote average marginal effects of various cooperation patterns (columns) on product innovation. Dependent variables: Product innovation. Reference category for sectoral variables: construction sector. T statistics in parentheses. Stars denote significance of the estimates as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5.9: Impact of Various Cooperation Patterns on Product Innovation: International Partners[a]

	Austria			Czech Republic			Distant Partners		
	all	RD	Appl	all	RD	Appl	all	RD	Appl
Cooperation	.080	.161	.077	.071	O	.071	.166*	.094	.157*
	(1.43)	(.850)	(1.36)	(.830)	(.)	(.830)	(2.57)	(.600)	(2.40)
Firm Size	.023	.023	.024	.022	.024	.022	.019	.024	.020
	(1.22)	(1.19)	(1.25)	(1.11)	(1.23)	(1.11)	(1.01)	(1.22)	(1.02)
R&D Contribution	.372***	.365***	.372***	.373***	.374***	.373***	.343***	.369***	.348***
	(10.72)	(10.18)	(10.74)	(10.79)	(10.85)	(10.79)	(9.19)	(10.34)	(9.40)
Manufacturing Sector	.067	.079	.067	.075	.079	.075	.061	.079	.062
	(1.30)	(1.55)	(1.31)	(1.48)	(1.54)	(1.48)	(1.21)	(1.55)	(1.22)
Service Sector	.012	.019	.014	.025	.026	.025	.009	.025	.012
	(.180)	(.280)	(.210)	(.370)	(.390)	(.370)	(.130)	(.380)	(.180)
Observations	399	399	399	399	399	399	399	399	399
McFadden's R^2	.20	.20	.20	.20	.20	.20	.21	.20	.21

[a] Table entries denote average marginal effects of various cooperation patterns (columns) on product innovation. Dependent variables: Product innovation. Reference category for sectoral variables: construction sector. T statistics in parentheses. Stars denote significance of the estimates as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5.10: Impact of Various Cooperation Patterns on Process Innovation: National Partners[a]

	Lower Bavaria			Bavaria			Munich			Germany		
	all	RD	Appl	all	RD	Appl	all	RD	Appl	all	RD	Appl
Cooperation	.028	.025	.015	-.032	-.046	-.035	.018	O	-.076	-.031	-.025	-.009
	(.740)	(.550)	(.390)	(-.830)	(-.790)	(-.900)	(.480)	(.)	(-1.41)	(-.710)	(-.410)	(-.210)
Firm Size	.049***	.048***	.050***	.050***	.052***	.049	.050***	.050***	.050***	.051***	.050***	.050***
	(3.42)	(3.30)	(3.45)	(3.47)	(3.54)	(3.41)	(3.43)	(3.46)	(3.47)	(3.51)	(3.48)	(3.46)
R&D Contribution	.164***	.158***	.166***	.170***	.172***	.168***	.165***	.166***	.166***	.174***	.171***	.168***
	(4.29)	(3.85)	(4.34)	(4.40)	(4.42)	(4.38)	(4.32)	(4.33)	(4.34)	(4.35)	(4.27)	(4.26)
Manufacturing Sector	.018	.015	.017	.012	.013	.013	.017	.016	.016	.017	0.016	.016
	(.370)	(.310)	(.360)	(.250)	(.270)	(.270)	(.350)	(.330)	(.330)	(.360)	(.330)	(.340)
Service Sector	.006	.002	.005	.003	.004	.003	.004	.004	.004	.008	.006	.004
	(.100)	(.030)	(.070)	(.050)	(.070)	(.040)	(.070)	(.060)	(.070)	(.120)	(.090)	(.070)
Observations	399	399	399	399	399	399	399	399	399	399	399	399
McFadden's R^2	.13	.13	.13	.13	.13	.14	.13	.13	.14	.13	.13	.13

[a] Table entries denote average marginal effects of various cooperation patterns (columns) on process innovation. Dependent variables: Process innovation. Reference category for sectoral variables: construction sector. T statistics in parentheses. Stars denote significance of the estimates as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5.11: Impact of Various Cooperation Patterns on Process Innovation: International Partners[a]

	Austria			Czech Republic			Distant Partners		
	all	RD	Appl	all	RD	Appl	all	RD	Appl
Cooperation	-.054	.053	-.043	-.027	O	-.027	-.159**	-.032	-.145**
	(-1.03)	(.500)	(-.820)	(-.390)	(.)	(-.390)	(-2.88)	(-.310)	(-2.62)
Firm Size	.051***	.049***	.050***	.051***	.050***	.051***	.055***	.050***	.054***
	(3.48)	(3.39)	(3.45)	(3.47)	(3.46)	(3.47)	(3.75)	(3.47)	(3.72)
R&D Contribution	.167***	.162***	.167***	.166***	.166***	.166***	.190***	.167***	.187***
	(4.38)	(4.18)	(4.36)	(4.35)	(4.33)	(4.35)	(5.09)	(4.34)	(4.97)
Manufacturing Sector	.022	.016	.021	.017	.016	.017	.035	.016	.034
	(.460)	(.330)	(.440)	(.360)	(.330)	(.360)	(.750)	(.330)	(.710)
Service Sector	.012	-.001	.009	.004	.004	.004	.011	.004	.009
	(.190)	(-.010)	(.140)	(.070)	(.060)	(.070)	(.180)	(.070)	(.140)
Observations	399	399	399	399	399	399	399	399	399
McFadden's R^2	.14	.13	.13	.13	.13	.13	.15	.13	.15

[a] Table entries denote average marginal effects of various cooperation patterns (columns) on process innovation. Dependent variables: Process innovation. Reference category for sectoral variables: construction sector. T statistics in parentheses. Stars denote significance of the estimates as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5.12: Impact of Various Cooperation Patterns on Non-Technological Innovation: National Partners[a]

	Lower Bavaria			Bavaria			Munich			Germany		
	all	RD	Appl	all	RD	Appl	all	RD	Appl	all	RD	Appl
Cooperation	.056	-.035	.092*	.122**	.032	.160***	.061	O	.085	.060	.021	.095
	(1.17)	(-.500)	(1.97)	(2.65)	(.380)	(3.52)	(1.30)	(.)	(1.39)	(1.07)	(.230)	(1.71)
Firm Size	.043*	.045*	.044*	.043*	.042	.046	.044*	.043*	.043*	.042	.043*	.042
	(2.01)	(2.07)	(2.07)	(2.03)	(1.93)	(2.19)	(2.02)	(2.01)	(2.00)	(1.93)	(2.00)	(1.96)
R&D Contribution	.206***	.219***	.212***	.193***	.204***	.198***	.207***	.209***	.208***	.191***	.204***	.187***
	(3.97)	(3.93)	(4.12)	(3.72)	(3.83)	(3.85)	(4.01)	(4.04)	(4.02)	(3.52)	(3.69)	(3.50)
Manufacturing Sector	.150**	.148**	.153**	.156**	.148**	.156**	.149**	.147**	.147**	.141*	.146**	.137*
	(2.67)	(2.63)	(2.73)	(2.79)	(2.62)	(2.82)	(2.66)	(2.61)	(2.62)	(2.51)	(2.61)	(2.43)
Service Sector	.114	.108	.117	.107	.107	.109	.112	.107	.107	.098	.106	.097
	(1.57)	(1.49)	(1.62)	(1.49)	(1.48)	(1.53)	(1.54)	(1.48)	(1.49)	(1.34)	(1.46)	(1.33)
Observations	399	399	399	399	399	399	399	399	399	399	399	399
McFadden's R^2	.09	.09	.09	.09	.09	.11	.09	.09	.09	.09	.09	.09

[a] Table entries denote average marginal effects of various cooperation patterns (columns) on non-technological innovation. Dependent variables: Non-technological innovation. Reference category for sectoral variables: construction sector. T statistics in parentheses. Stars denote significance of the estimates as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5.13: Impact of Various Cooperation Patterns on Non-Technological Innovation: International Partners[a]

	Austria			Czech Republic			Distant Partners		
	all	RD	Appl	all	RD	Appl	all	RD	Appl
Cooperation	.105	-.029	.119	.058	O	.058	.090	-.288	.124
	(1.65)	(-0.17)	(1.88)	(.61)	(.)	(.61)	(1.24)	(-1.80)	(1.69)
Firm Size	.043*	.044*	.044 *	.042	.043*	.042	.041	.045*	.041
	(2.01)	(2.02)	(2.04)	(1.91)	(2.01)	(1.91)	(1.91)	(2.07)	(1.87)
R&D Contribution	.204***	.210***	.204***	.207***	.209***	.207***	.190***	.226***	.185***
	(3.95)	(3.99)	(3.95)	(4.01)	(4.04)	(4.01)	(3.49)	(4.34)	(3.42)
Manufacturing Sector	.132*	.146**	.129*	.144*	.147**	.144*	.137*	.146**	.133*
	(2.32)	(2.61)	(2.28)	(2.55)	(2.61)	(2.55)	(2.42)	(2.62)	(2.36)
Service Sector	.089	.108	.088	.106	.107	.106	.098	.109	.096
	(1.22)	(1.49)	(1.21)	(1.46)	(1.48)	(1.46)	(1.36)	(1.52)	(1.34)
Observations	399	399	399	399	399	399	399	399	399
McFadden's R^2	.09	.09	.09	.09	.09	.09	.09	.09	.09

[a] Table entries denote average marginal effects of various cooperation patterns (columns) on non-technological innovation. Dependent variables: Non-technological innovation. Reference category for sectoral variables: construction sector. T statistics in parentheses. Stars denote significance of the estimates as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

In summary, the empirical results show that in Lower Bavaria, one example of an economically successful LMT region, firms cooperate predominantly with local and regional cooperation partners. Hence, in line with the literature on the embeddedness of knowledge in the regional and institutional context (see, for example, Gertler, 2004), geographic proximity seems to be important for knowledge spillovers. Regarding the form of cooperation, application-oriented cooperations prevail, suggesting that in this region, cooperation supports development rather than research.

When looking at the innovation implications of cooperation, in line with the first hypothesis, cooperation on various spatial scales is indeed important for innovation. This suggests that firms exploit knowledge from outside the region in order to innovate and that a broad scope of learning opportunities is particularly beneficial. When differentiating between the impact that cooperation on different geographical scales has for the likelihood of firms innovating, it becomes evident that the impact of cooperation differs between the various geographic levels. While cooperation with regional, i.e. Lower Bavarian or Bavarian, partners significantly increases the likelihood of firms introducing non-technological innovations, firms that cooperate with distant partners are more likely to introduce product innovations. This result suggests that firms only engage in cooperation with distant partners when the acquired knowledge is not available at the regional level. When differentiating between the distinct forms of cooperation, it becomes evident that it is application-oriented cooperation that drives the relation. This finding suggests that in the region of Lower Bavaria, an example of a LMT region, R&D-intensive cooperation is less relevant for innovation, with application-oriented cooperation, i.e. production, procurement and sales cooperation with suppliers, customers, or – in some cases– competitors, instead being more important. This suggests that firms primarily apply a DUI mode of innovation, irrespective of whether they introduce product or lower-threshold innovations.

5.6 Discussion and Conclusion

The essay studied the interplay between spatial cooperation patterns and innovation outcomes of firms in the German rural, LMT region of Lower Bavaria. Drawing from the existing literature on the spatial scale of cooperation (for example Bathelt *et al.*, 2004;

Cooke, 2001) and on different types of knowledge and modes of innovation (Asheim *et al.*, 2011; Asheim and Gertler, 2005; Jensen *et al.*, 2007), two research hypotheses regarding the impact of cooperation on innovation in this type of region were formulated and empirically tested. These hypotheses can be derived directly from the existing literature, yet they have not been tested systematically in the German context. Thanks to the database of original micro-data of Lower Bavarian firms that explicitly reports cooperation patterns of these firms with the surrounding regions on different spatial scales the empirical analysis provided an in-depth analysis of the interplay between the spatial scale of cooperation and the form of cooperation. On the output side, the empirical analysis has differentiated between product innovation, process innovation and non-technological innovation in order to provide a fine-grained picture of the innovation implications that the various cooperation patterns in this region entail. Overall, the following major findings can be summarised:

(1) In the region of Lower Bavaria, local and regional cooperation dominates. This result is in line with the literature on the embeddedness of knowledge in the regional and institutional context (see, for example, Gertler, 2004) and suggests that firms generate and exploit regional agglomeration effects.

(2) In the region of Lower Bavaria, application-oriented cooperation dominates. Regional firms cooperate predominantly with other firms, such as suppliers, customers, or even competitors, while cooperation with universities and research institutes is less frequent. Correspondingly, application-oriented cooperation such as production, procurement and sales cooperation is more frequent than explicit R&D cooperation. This result suggests that regional firms use cooperation particularly to acquire synthetic, engineering-based knowledge that is particularly relevant when pursuing a DUI mode of innovation (Asheim and Gertler, 2005; Jensen *et al.*, 2007).

(3) With respect to the relation between cooperation and innovation, results show that firms that cooperate with partners from a more diverse set of regions have a higher likelihood of innovating, even when controlling for the size and sector of the firm as well as for firms' R&D expenditures. This result shows that the interplay between local and global sourcing activities is important. This might stem from the creation of cluster effects in combination with the simultaneous enlargement of the knowledge base by non-local

or non-regional sources. The finding corresponds well with the literature on knowledge bases and different modes of innovation (see, for example, Asheim *et al.*, 2011; Asheim and Gertler, 2005; Jensen *et al.*, 2007), as well as with other empirical works on cooperation in non-core regions (Fitjar and Rodríguez-Pose, 2011; Grillitsch and Nilsson, 2015; Lagendijk and Lorentzen, 2007).

(4) The findings also show that firms' cooperation on different spatial scales entails different innovation outcomes. Hence, results show that cooperation with regional partners positively and statistically significantly correlates with a higher likelihood of introducing low-threshold, i.e. non-technological, innovations. In contrast, cooperation with partners in distant regions is positively and statistically significantly correlated with product innovations that presumably require more analytical knowledge. Overall, the finding suggests that firms indeed exploit different spatial knowledge sources, depending on the required knowledge base, and that these translate into different innovation outcomes.

(5) In Lower Bavaria, it is not R&D cooperation that affects the likelihood of a firm of innovating. Instead, application-oriented forms of cooperation, such as procurement, production, or sales cooperation with suppliers, customers or competitors seem to impact firms' innovativeness. This suggests that the increasing absorptive capacity (see, for example, Cohen and Levinthal, 1990) is an important prerequisite for learning and innovating in a LMT context.

Translated into the political context, the findings suggest that locally bounded network policies may not be sufficient for stimulating regional innovativeness. Instead, policies should also consider the benefits arising from spatially diverse, inter-regional cooperation when designing regional policies suited for LMT regions. With respect to the form of cooperation, the findings imply that an exclusive focus on R&D-based cooperation might neither be appropriate nor sufficient for stimulating the innovativeness of firms in LMT regions. In low-technology regions with a strong economic performance, less R&D-intensive forms of knowledge might thus be of greater importance, an implication that has also been put forward in other recent studies (for example Hansen and Winther, 2011 and 2014).

Even though the essay adds multiple new aspects to the academic debate on how cooperation impacts innovation of firms located in a German LMT border region, there are

some limitations to be noted. The essay uses micro-data of firms in Lower Bavaria, which limits the overall external validity of the results. Therefore, there may be certain unobserved, idiosyncratic regional factors that potentially drive the results in this particular region and would consequentially impede a transfer of results to other regions. In the case of Lower Bavaria, the comparatively strong regional automobile industry may be such a factor. This industry has frequently been identified as the main driver of regional growth. Given that the automobile plant located in the region constitutes a large production subsidiary to the BMW headquarters in Munich, innovation may, if at all, be driven rather by incremental process improvements facilitated by cooperation with suppliers. This suggests that in Lower Bavaria, regional growth is primarily demand-driven. As the demand for regional products is, however, largely determined by the competitiveness of regional products, the quality and innovativeness of regional products is likewise important, especially in a high-wage country such as Germany. Hence, it is plausible to identify the innovativeness of regional firms as an important prerequisite for regional growth in Lower Bavaria.

Table 5.14: Other European Second Tier LMT Regions[a]

Core City	Second Tier Region	GDP	HRST	Largest City (Inhabitants)
Munich	*Lower Bavaria*	*117*	*37.0*	*Landshut (65.322)*
Vienna	Upper Austria	126	36.1	Linz (191.501)
Copenhagen	Southern Denmark	114	40.2	Vejle (52.449)
Amsterdam	Friesland	104	40.5	Leeuwarden (96.568)
Frankfurt	Giessen	107	41.2	Giessen (76.680)
Stockholm	Smaland	108	39.6	Joenkoeping (89.369)
Brussels	West Flanders	112	43.6	Bruegge (117.170)

[a] Own depiction based on data from Eurostat Regional Database (2016); GDP=Regional GDP (PPS per inhabitant in % of the EU27 average); HRST=Share of Human Ressources in Science and Technology (in % of total workforce) for the year 2012.

Despite these idiosyncratic factors, Lower Bavaria may not be that atypical compared to other regions. Located at the second tier of a major city and characterised by a relatively strong economic performance, despite low levels of internal R&D, Lower Bavaria shares similar regional characteristics with several regions within the EU-15, for example Upper Austria, Southern Denmark, Småland, or West Flanders. All these regions display regional characteristics similar to those of Lower Bavaria in terms of location, internal R&D and economic performance (see Table 5.14). Due to this high degree of similarity,

it may be reasonable to assume that the region of Lower Bavaria constitutes a valid and typical example of a specific type of European region. The key findings of the essay may thus also be found in other economically successful LMT regions.

However, owing to the lack of comparable survey data, this presumption cannot be tested empirically. Moreover, a comparison of Lower Bavaria with regions that share similar structural characteristics but are less successful in economic and innovative terms may be an interesting endeavour. It would allow for an investigation of whether firms in these less successful regions lack cooperation linkages or whether cooperation linkages are also present, but do not affect firms' innovativeness. Finally, the essay only analyses correlations between cooperation and innovation. Hence, the results do not claim a causal interpretation of the relevant associations. Nonetheless, these correlation patterns already provide important insights for a better understanding of the interplay between the spatial scale of cooperation, the form of cooperation and the corresponding innovation outcomes of firms located in an economically successful LMT region with low internal R&D.

Appendix I

Appendix Part One

I.1 Synthetic Controls for Individual Border Regions

Burgenland - AT11

Table I.1: Balance Test: Burgenland

Variable	Burgenland	Synthetic Control
Employment Rate	.782	.786
Population Density	69.76	94.88
Patent Intensity	.112	.097
Primary Secor	.046	.047
Secondary Sector	.279	.280
Tertiary Sector	.664	.665
Hourly Wage	10.97	10.61
GDP per capita 1991	14806.35	14858.10
GDP per capita 1995	16794.62	16803.38
GDP per capita 2000	19238.92	19263.02

Table I.2: Synthetic Control: Burgenland

Region	NUTS Code	Weight
Namur	BE35	.210
Lüneburg	DE93	.096
Calabria	ITF6	.038
Norte	PT11	.076
Alentejo	PT18	.210
Cheshire	UKD2	.088
Highlands	UKM6	.282

Lower Austria - AT12

Table I.3: Balance Test: Lower Austria

Variable	Lower Austria	Synthetic Control
Employment Rate	.860	.857
Population Density	79.42	73.42
Patent Intensity	.232	.231
Primary Secor	.032	.032
Secondary Sector	.340	.339
Tertiary Sector	.616	.613
Hourly Wage	12.61	12.56
GDP per capita 1991	20069.59	20001.22
GDP per capita 1995	21112.13	21044.47
GDP per capita 2000	23899.33	23814.34

Table I.4: Synthetic Control: Lower Austria

Region	NUTS Code	Weight
Vorarlberg	AT34	.145
Lower Franconia	DE26	.036
Western Finland	FI19	.052
Northern Finland	FI1A	.100
Franche-Comté	FR43	.217
Emilia-Romagna	ITD5	.071
Basilicata	ITF5	.016
Alentejo	PT18	.035
Cumbria	UKD1	.192
Highlands	UKM6	.136

Vienna - AT13

Table I.5: Balance Test: Vienna

Variable	Vienna	Synthetic Control
Employment Rate	1.04	1.04
Population Density	3736.46	3651.24
Patent Intensity	.216	.204
Primary Secor	.001	.003
Secondary Sector	.195	.196
Tertiary Sector	.818	.818
Hourly Wage	18.02	18.08
GDP per capita 1991	33117.54	33083.95
GDP per capita 1995	34721.93	34689.96
GDP per capita 2000	40047.96	40013.12

Table I.6: Synthetic Control: Vienna

Region	NUTS Code	Weight
Brussels	BE10	.227
Walloon Brabant	BE31	.040
Hamburg	DE60	.124
Cologne	DEA2	.024
Rhinehessen Palatinate	DEB3	.039
Leipzig	DED3	.057
Campania	ITF3	.035
Inner London	UKI1	.083
Outer London	UKI2	.371

Carinthia - AT21

Table I.7: Balance Test: Carinthia

Variable	Carinthia	Synthetic Control
Employment Rate	.957	.956
Population Density	58.61	91.80
Patent Intensity	.200	.200
Primary Secor	.021	.022
Secondary Sector	.307	.307
Tertiary Sector	.667	.667
Hourly Wage	12.89	12.87
GDP per capita 1991	19969.78	19944.34
GDP per capita 1995	20988.81	20961.57
GDP per capita 2000	24126.13	24095.01

Table I.8: Synthetic Control: Carinthia

Region	NUTS Code	Weight
Tyrol	AT33	.127
Vorarlberg	AT34	.113
Western Finland	FI19	.069
Basse-Normandie	FR25	.143
Franche-Comté	FR43	.039
Auvergne	FR72	.177
Luxembourg	LU00	.031
Norte	PT11	.042
Cumbria	UKD1	.030
West Wales	UKL1	.229

Styria - AT22

Table I.9: Balance Test: Styria

Variable	Styria	Synthetic Control
Employment Rate	.953	.953
Population Density	72.21	138.96
Patent Intensity	.257	.256
Primary Secor	.025	.026
Secondary Sector	.353	.354
Tertiary Sector	.611	.612
Hourly Wage	12.43	12.42
GDP per capita 1991	19357.77	19381.92
GDP per capita 1995	20909.14	20934.47
GDP per capita 2000	24674.13	24703.6

Table I.10: Synthetic Control: Styria

Region	NUTS Code	Weight
Vorarlberg	AT34	.030
Lower Franconia	DE26	.109
Brunswick	DE91	.254
Western Finland	FI19	.075
Franche-Comté	FR43	.076
Luxembourg	LU00	.075
Norte	PT11	.035
Centro	PT16	.240
Cumbria	UKD1	.061
Cheshire	UKD2	.045

Upper Austria - AT31

Table I.11: Balance Test: Upper Austria

Variable	Upper Austria	Synthetic Control
Employment Rate	.978	.973
Population Density	113.65	164.87
Patent Intensity	.305	.295
Primary Secor	.023	.028
Secondary Sector	.405	.406
Tertiary Sector	.556	.559
Hourly Wage	13.46	13.58
GDP per capita 1991	23448.47	23427.14
GDP per capita 1995	24233.82	24214.33
GDP per capita 2000	28070.97	28039.48

Table I.12: Synthetic Control: Upper Austria

Region	NUTS Code	Weight
Vorarlberg	AT34	.055
Stuttgart	DE11	.211
Navarra	ES22	.500
Western Finland	FI19	.006
Luxembourg	LU00	.001
Groningen	NL11	.094
Centro	PT16	.048
Cheshire	UKD2	.085

Lower Bavaria - DE22

Table I.13: Balance Test: Lower Bavaria

Variable	Lower Bavaria	Synthetic Control
Employment Rate	.906	.924
Population Density	111.18	238.78
Patent Intensity	.258	.130
Primary Secor	.021	.018
Secondary Sector	.396	.394
Tertiary Sector	.578	.579
Hourly Wage	12.64	11.72
GDP per capita 1991	19192.16	19321.93
GDP per capita 1995	23013.55	22981.5
GDP per capita 2000	24827.45	24855.93

Table I.14: Synthetic Control: Lower Bavaria

Region	NUTS Code	Weight
Note	PT11	.228
Centro	PT16	.075
Tees Valley and Durham	UKC1	.157
Cheshire	UKD2	.328
North Eastern Scotland	UKM5	.147
Highlands	UKM6	.065

Upper Palatinate - DE23

Table I.15: Balance Test: Upper Palatinate

Variable	Upper Palatinate	Synthetic Control
Employment Rate	.968	.950
Population Density	109.27	298.50
Patent Intensity	.489	.367
Primary Secor	.017	.019
Secondary Sector	.374	.369
Tertiary Sector	.607	.606
Hourly Wage	12.91	12.99
GDP per capita 1991	19717.17	19756.03
GDP per capita 1995	23177.77	23150.99
GDP per capita 2000	26409.15	26393.96

Table I.16: Synthetic Control: Upper Palatinate

Region	NUTS Code	Weight
Lower Franconia	DE26	.201
Rhinehessen-Palatinate	DEB3	.017
North Brabant	NL41	.125
Centro	PT16	.141
Cheshire	UKD2	.237
Lancashire	UKD4	.234
North Eastern Scotland	UKM5	.045

Upper Franconia - DE24

Table I.17: Balance Test: Upper Franconia

Variable	Upper Franconia	Synthetic Control
Employment Rate	.966	.961
Population Density	152.95	231.37
Patent Intensity	.335	.326
Primary Secor	.011	.012
Secondary Sector	.355	.355
Tertiary Sector	.634	.634
Hourly Wage	13.32	13.17
GDP per capita 1991	21157.39	21163.07
GDP per capita 1995	22858.43	22862.73
GDP per capita 2000	24276.68	24280.41

Table I.18: Synthetic Control: Upper Franconia

Region	NUTS Code	Weight
Freiburg	DE13	.283
Lower Franconia	DE26	.013
Swabia	DE27	.053
Muenster	DEA3	.211
Eastern Finland	FI13	.013
Norte	PT11	.092
Northumberland and Tyne and Wear	UKC2	.087
West Wales	UKL1	.154
North Eastern Scotland	UKM5	.094

Berlin - DE30

Table I.19: Balance Test: Berlin

Variable	Berlin	Synthetic Control
Employment Rate	.872	.914
Population Density	3862.18	579.34
Patent Intensity	.261	.111
Primary Secor	.001	.012
Secondary Sector	.209	.275
Tertiary Sector	.801	.721
Hourly Wage	16.49	14.39
GDP per capita 1991	29618.62	29379.4
GDP per capita 1995	26498.33	25966.31
GDP per capita 2000	26281	26725.57

Table I.20: Synthetic Control: Berlin

Region	NUTS Code	Weight
Brussels	BE10	.067
Leipzig	DED3	.573
Alps-French Riviera	FR82	.218
North Eastern Scotland	UKM5	.143

Brandenburg - DE40

Table I.21: Balance Test: Brandenburg

Variable	Brandenburg	Synthetic Control
Employment Rate	.756	.757
Population Density	87.12	159.53
Patent Intensity	.103	.100
Primary Secor	.017	.017
Secondary Sector	.316	.315
Tertiary Sector	.666	.665
Hourly Wage	12.42	12.41
GDP per capita 1991	19090.62	19072.25
GDP per capita 1995	16222.98	16206.97
GDP per capita 2000	18394.71	18377.21

Table I.22: Synthetic Control: Brandenburg

Region	NUTS Code	Weight
Walloon Brabant	BE31	.017
Hainaut	BE32	.057
Lüneburg	DE93	.016
Leipzig	DED3	.153
Schleswig-Holstein	DEE0	.468
Thuringia	DEG0	.220
Highlands	UKM6	.069

Mecklenburg-Western Pomerania - DE80

Table I.23: Balance Test: Mecklenburg Western-Pomerania

Variable	Mecklenburg Western-Pomerania	Synthetic Control
Employment Rate	.770	.770
Population Density	78.10	150.79
Patent Intensity	.048	.056
Primary Secor	.030	.030
Secondary Sector	.243	.243
Tertiary Sector	.724	.724
Hourly Wage	11.87	11.81
GDP per capita 1991	18109.22	18114.33
GDP per capita 1995	16090.26	16090.56
GDP per capita 2000	17869.91	17868.14

Table I.24: Synthetic Control: Mecklenburg Western-Pomerania

Region	NUTS Code	Weight
Namur	BE35	.127
Rhinehessen-Palatinate	DEB3	.239
Schleswig-Holstein	DEE0	.177
Andalusia	ES61	.113
Nord-Pas-de-Calais	FR30	.017
Calabria	ITF6	.258
Highlands	UKM6	.034
Northern Ireland	UKN0	.035

Chemnitz - DED1

Table I.25: Balance Test: Chemnitz

Variable	Chemnitz	Synthetic Control
Employment Rate	.837	.869
Population Density	275.58	200.37
Patent Intensity	.086	.046
Primary Secor	.010	.018
Secondary Sector	.360	.355
Tertiary Sector	.629	.625
Hourly Wage	11.02	10.33
GDP per capita 1991	15845.83	15813.52
GDP per capita 1995	15327.51	15257.19
GDP per capita 2000	16927.57	16935.69

Table I.26: Synthetic Control: Chemnitz

Region	NUTS Code	Weight
Leipzig	DED3	.176
Asturias	ES12	.359
Borte	PT11	.253
West Wales	UKL1	.207
North Eastern Scotland	UKM5	.005

Dresden - DED2

Table I.27: Balance Test: Dresden

Variable	Dresden	Synthetic Control
Employment Rate	.801	.814
Population Density	222.13	212.87
Patent Intensity	.204	.138
Primary Secor	.010	.014
Secondary Sector	.336	.332
Tertiary Sector	.655	.651
Hourly Wage	12.55	11.95
GDP per capita 1991	18836.22	18832.62
GDP per capita 1995	16487.57	16473.12
GDP per capita 2000	18368.44	18389.74

Table I.28: Synthetic Control: Dresden

Region	NUTS Code	Weight
Lüneburg	DE93	.051
Rhinehessen-Palatinate	DEB3	.041
Leipzig	DED3	.192
Schleswig-Holstein	DEE0	.057
Thuringia	DEG0	.375
Norte	PT11	.113
Tees Valley and Durham	UKC1	.171

Friuli-Venezia Giulia - ITD4

Table I.29: Balance Test: Friuli-Venezia Giulia

Variable	Friuli-Venezia Giulia	Synthetic Control
Employment Rate	1.01	.998
Population Density	150.80	292.88
Patent Intensity	.183	.190
Primary Secor	.019	.027
Secondary Sector	.263	.266
Tertiary Sector	.688	.691
Hourly Wage	11.82	11.58
GDP per capita 1991	23742.06	23724.81
GDP per capita 1995	26558.35	26510.25
GDP per capita 2000	28959.06	28912.61

Table I.30: Synthetic Control: Friuli-Venezia-Giulia

Region	NUTS Code	Weight
Brussels	BE10	.016
Cologne	DEA2	.225
Limousin	FR63	.097
Bolzano	ITD1	.334
Veneto	ITD3	.069
Luxembourg	LU00	.021
Norte	PT11	.053
Centro	PT16	.143
Berkshire, Buckinghamshire and Oxfordshire	UKJ1	.003
North Eastern Scotland	UKM5	.039

I.2 Logistic Regression for Propensity Scores

Table I.31: Logistic Regression Model[a]

Border Location	
Share < 6 Years	-10.917
	(10.503)
Share 6 < 18 Years	-10.271
	(10.315)
Share 18 < 25 Years	-11.001
	(10.479)
Share 25 < 30 Years	-11.045
	(10.283)
Share 30 < 50 Years	-10.775
	(10.330)
Share 50 < 65 Years	-10.270
	(10.368)
Share 65 < 75 Years	-10.674
	(10.331)
Share > 75 Years	-10.548
	(10.354)
Population Density	-.001
	(.002)
Share Foreigners	-.220
	(.203)
Umemployment Rate	.143
	(.115)
Youth Unemployyment	.143
	(.160)
Income per capita	.001
	(.001)
Share Unskilled Labor	.211
	(.174)
Share University Degree	.357**
	(.163)
Clearance Rate	.184**
	(.049)
Constant	1051.072
	(1034.203)
Observations	428
McFadden's R^2	.385

[a] Table entries denote regression coefficients of a logistic regression model. Dependent variable: border region. Stars denote significance of the estimates as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

I.3 Border Regions and Matched Controls

Table I.32: Border Regions and Matched Control Regions

Border Regions		Matched Control Regions	
Regen	(DE229)	Altenburger Land	(DEg0m)
Weiden i. d. Opf. kreisfreie Stadt	(DE233)	Dingolfing-Landau	(DE22c)
Cham	(DE235)	Dessau-Roßlau, kreisfreie Stadt	(DEe01)
Neustadt a. d. Waldnaab	(DE237)	Suhl, kreisfreie Stadt	(DE04)
Schwandorf	(DE239)	Ostprignitz-Ruppin	(DE416)
Tirschenreuth	(DE23a)	Rügen	(DE80h)
Hof, kreisfreie Stadt	(DE244)	Eichsfeld	(DEg06)
Hof, Landkreis	(DE249)	Bernkastel-Wittlich	(DEb22)
Frankfurt (Oder), kreisfreie Stadt	(DE411)	Demmin	(DE808)
Barnim	(DE412)	Darmstadt, kreisfreie Stadt	(DE711)
Märkisch-Oderland	(DE413)	Jena, kreisfreie Stadt	(DEg03)
Oder-Spree	(DE415)	Haßberge	(DE267)
Uckermark	(DE418)	Sömmerda	(DEg0d)
Cottbus, kreisfreie Stadt	(DE422)	Rottal-Inn	(DE22a)
Spree-Neiße	(DE429)	Güstrow	(DE809)
Ostvorpommern	(DE80f)	Döbeln	(DEd33)
Uecker-Randow	(DE80i)	Kyffhäuserkreis	(DEg0a)
Plauen, kreisfreie Stadt	(DEd12)	Bitburg-Prüm	(DEb23)
Annaberg	(DEd14)	Hoyerswerda, kreisfreie Stadt	(DEd23)
Freiberg	(DEd16)	Weimar, kreisfreie Stadt	(DEg05)
Vogtlandkreis	(DEd17)	Leipziger Land	(DEd34)
Mittlerer Erzgebirgskreis	(DEd18)	Zwickauer Land	(DEd1c)
Aue-Schwarzenberg	(DEd1b)	Muldentalkreis	(DEd35)
Bautzen	(DEd24)	Torgau-Oschatz	(DEd36)
Löbau-Zittau	(DEd28)	Nordhausen	(DEg07)
Sächsische Schweiz	(DEd29)	Riesa-Großenhain	(DEd27)
Weißeritzkreis	(DEd2a)	Saalfeld-Rudolstadt	(DEg0i)

I.4 Effect Size of the Schengen Acquis on the Rate of Burglaries

Table I.33: Difference-in-Difference Estimates on Matched Samples: Effect Size Burglaries[a]

	Log Burglary	Log Burglary	Log Burglary	Log Burglary
DID	.527**	.517*	.555**	.559**
	(.188)	(.199)	(.197)	(.196)
Year=2008	-.552**	-.549**	-.605**	-.549**
	(.179)	(.179)	(.188)	(.187)
Border=1	-.622**	-.617**	-.615**	-.619**
	(.202)	(.209)	(.201)	(.184)
Clearance Rate		-.001	.002	.003
		(.004)	(.003)	(.003)
GDP per capita			.001	-.001
			(.001)	(.001)
GDP Growth Rate			-1.251	-.207
			(.887)	(.915)
Pop. Density				.001**
				(.001)
Yearly Dummies	√	√	√	√
Constant	-0.091	-.054	-.659	-.473
	(.152)	(.192)	(.358)	(.382)
Onservations	270	270	270	270
McFadden R^2	.118	.115	.158	.266

[a] Table entries denote estimated coefficients, robust standard errors (in parentheses) and the level of significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Dependent variable: Log rate of burglary

Appendix II

Appendix Part Two

II.1 Firm Survey Questionnaire

IHK Niederbayern

Handwerkskammer Niederbayern-Oberpfalz

Niedersächsisches Institut für Wirtschaftsforschung

Ihre Zeichen/Nachricht vom

«ZEILE0»
«ZEILE1»
«ZEILE2»
«ZEILE3»
«ZEILE4»
«ZEILE5»
«ZEILE6»
«ZEILE7»

Ihr Ansprechpartner/Unser Zeichen

E-Mail

Tel.

Januar 2013

Standortverflechtungsanalyse für den Wirtschaftsstandort Niederbayern

«Anrede»

Standortverflechtungsanalyse für den Wirtschaftsstandort Niederbayern

«IHKNR» «IHKNR»

Rückadresse:	**Für die Onlinebeantwortung:**
«Firma» «Firma1» «Firma2» «Strasse» «Plz» «Ort»	Wir bieten Ihnen unseren Fragebogen auch **online** an. Die Anmeldemaske finden Sie unter: **https://www.umfragen.ihk.de** Kennung: **«Kennung»** Kennwort: **«Kennwort»** **oder per Fax: 02 31 / 97 46 - 46 317** **Bitte antworten Sie bis XX.XX.XXXX**

Erläuterungen zum Ausfüllen des Fragebogens

Bitte füllen Sie den Fragebogen gut leserlich aus, indem Sie…

- in die weißen Kästchen ein Kreuz machen

  Beispiel: F&E Abteilung Ja ☒ Nein ☐

  Falls Sie eine Antwort korrigieren möchten, füllen Sie bitte das fälschlich angekreuzte Kästchen vollständig aus und kreuzen Sie anschließend das richtige Kästchen an.

  Beispiel: F&E Abteilung Ja ■ Nein ☒

- in die unterstrichenen Felder Zahlen oder Text in Druckbuchstaben schreiben

  Beispiel: Anzahl der Mitarbeiter/innen: ca. 2000

- in die weißen Textfelder Ihre Antworten und Anmerkungen schreiben

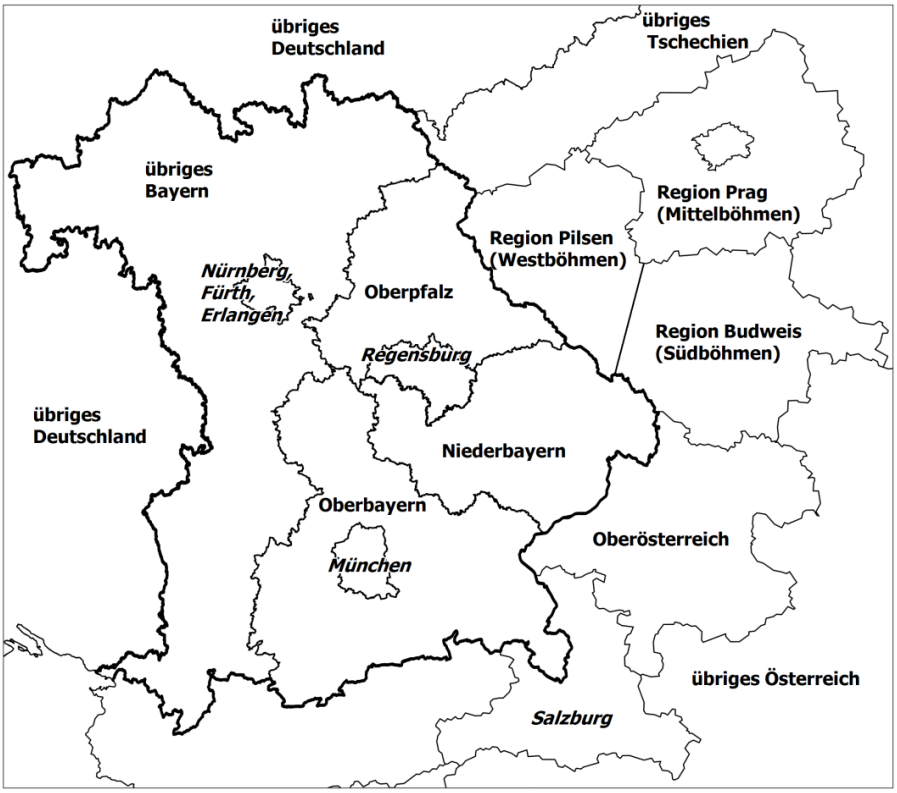
  Beispiel: In welchem Netzwerk oder Cluster ist Ihr Betrieb Mitglied? z.B. M.A.I., Carbon, M^4

Anmerkungen zu den Regionen:

Im Fragebogen stellen wir Ihnen einige Fragen, in denen Sie die Regionen innerhalb und außerhalb des IHK Bezirks Niederbayern nennen sollen, in denen Ihr Betrieb Kooperationen und Geschäftsbeziehungen hat.

Die Liste der Regionen umfasst dabei die folgenden, in der Karte eingezeichneten Gebiete:

- Städte und Landkreise in Niederbayern
- Stadt und Landkreis Regensburg
- Stadt und Landkreis München
- Städte Nürnberg/Fürth/Erlangen
- Oberpfalz
- Oberbayern
- übriges Bayern
- übriges Deutschland
- Oberösterreich
- Region Salzburg
- übriges Österreich
- Region Budweis (Südböhmen)
- Region Pilsen (Westböhmen)
- Region Prag (Mittelböhmen)
- übriges Tschechien
- übriges Osteuropa (ohne Tschechien)
- übriges Westeuropa (ohne Deutschland und Österreich)
- übrige Welt



ABSCHNITT A: FRAGEN ZUM BETRIEB

☞ *Im ersten Abschnitt des Fragebogens haben wir einige allgemeine Fragen zu den strukturellen Merkmalen Ihres Betriebes.*
☞ *Betrieb bezeichnet im Nachfolgenden den im Anschreiben genannten Standort einschließlich zugehöriger rechtlich unselbständiger Niederlassungen/Betriebsstätten in Niederbayern.*

1. In welchem der folgenden Wirtschaftszweige ist Ihr Betrieb überwiegend tätig?

☞*Falls Ihr Betrieb keinem der genannten Wirtschaftszweige zugeordnet werden kann, kreuzen Sie bitte den Wirtschaftszweig an, mit dem die größte Übereinstimmung besteht.*
☞*Bitte nur **eine** Antwort ankreuzen!*

Fahrzeugbau	○	Erzeugung und Bearbeitung von Metall	○
Elektronik	○	Chemie, Kunststoffverarbeitung, Gummiwaren, Pharmazie	○
Baugewerbe	○	Nahrungs- und Genussmittel	○
Maschinenbau	○	Holzgewerbe (ohne Möbel)	○
Bergbau, Stein und Erde	○	Möbel, Schmuck, Musikinstrumente, Sportgeräte, Spielwaren	○
Glas, Porzellan, Keramik	○	Druckerei und Vervielfältigung	○
Textil, Bekleidung, Leder	○	Papier und Pappe	○
Feinmechanik, Optik	○	Logistik und Transportgewerbe	○
Energieerzeugung	○	Informations- und Kommunikationsdienstleistungen	○
Recycling	○	Freiberufliche, wissenschaftliche und technische Dienste	○
Sonstiges	○		

2. Seit wann ist Ihr Betrieb an diesem Standort ansässig?

Vor 1990	○
Zwischen 1990 und 2000	○
Nach 2000	○

3. Welche Art von Aktivitäten führen Sie am Standort aus?

☞ *Mehrfachnennungen sind möglich!*

Beschaffung	○
Produktion von Waren/Dienstleistungen	○
Absatz	○
Forschung und Entwicklung	○
Personalverwaltung	○
Finanzverwaltung	○
Aus- und Weiterbildung	○
Geschäftsführung	○

4. Wie lässt sich Ihr Betrieb charakterisieren?

Dieser Betrieb ist der einzige Standort	○	☞ *weiter mit Frage 7*
Dieser Betrieb ist der Hauptsitz	○	☞ *weiter mit Frage 6*
Dieser Betrieb ist eine Niederlassung	○	☞ *weiter mit Frage 5*

5. Wo befindet sich der Hauptsitz?

Hauptsitz in:_____

«IHKNR» «IHKNR»
«Kennung»

6. Wo befinden sich die (übrigen) Niederlassungen/Betriebsstätten Ihres Betriebes/ Unternehmens?

☞ *Mehrfachnennungen sind möglich!*

Stadt und LK Passau	○
LK Regen	○
LK Deggendorf	○
LK Freyung-Grafenau	○
LK Kelheim	○
Stadt Straubing/ LK Straubing-Bogen	○
LK Rottal-Inn	○
LK Dingolfing-Landau	○
Stadt und LK Landshut	○
Stadt und LK Regensburg	○
Stadt und LK München	○
Städte Nürnberg/ Fürth/ Erlangen	○
Oberpfalz	○
Oberbayern	○
übriges Bayern	○
übriges Deutschland (ohne Bayern)	○
Oberösterreich	○
Region Salzburg	○
übriges Österreich	○
Region Budweis (Südböhmen)	○
Region Pilsen (Westböhmen)	○
Region Prag (Mittelböhmen)	○
übriges Tschechien	○
übriges Osteuropa (ohne Tschechien)	○
übriges Westeuropa (ohne Deutschland und Österreich)	○
übrige Welt	○

7. Wie hoch war der Jahresumsatz Ihres <u>Betriebes</u> im Jahr 2011 in etwa?

☞ *Zur Erinnerung: Mit Betrieb ist der im Anschreiben genannte Standort einschließlich zugehöriger rechtlich unselbständiger Niederlassungen/Betriebsstätten in Niederbayern gemeint.*

- bis zu 1 Mio. Euro ○
- mehr als 1 Mio. Euro, aber max. 5 Mio. Euro ○
- mehr als 5 Mio. Euro, aber max. 50 Mio. Euro ○
- mehr als 50 Mio. Euro ○

8. Wie viele Mitarbeiter (sozialversicherungspflichtige Beschäftigte, inkl. Auszubildende, Teilzeit- und Saisonkräfte) sind gegenwärtig in Ihrem Betrieb beschäftigt?

ca. _____ Mitarbeiter/innen

9. Aus welchen der folgenden Regionen kommen die Mitarbeiter (sozialversicherungspflichtige Beschäftigte, inkl. Auszubildende, Teilzeit- und Saisonkräfte), die Ihr Betrieb in den letzten 3 Jahren eingestellt hat?

☞ *Mehrfachnennungen sind möglich!*

- gleicher Landkreis ○
- Niederbayern ○
- übriges Bayern ○
- übriges Deutschland ○
- Österreich ○
- Tschechien ○
- übriges Ausland ○

ABSCHNITT B: VERFLECHTUNGEN INNERHALB UND AUSSERHALB NIEDERBAYERNS

☞ *Im nächsten Abschnitt interessieren uns die regionalen und überregionalen Verflechtungen und Kooperationen Ihres Betriebes.*

10. Aus welchen der folgenden Regionen <u>bezieht</u> Ihr Betrieb <u>Vorleistungen</u>?
Bitte kreuzen Sie alle Regionen an, aus denen Ihr Betrieb Vorleistungen bezieht.

☞ *Vorleistungen sind alle von anderen Betrieben oder Einrichtungen bezogenen Roh-, Hilfs- und Betriebsstoffe, Handelswaren und fremden Dienstleistungen, die für die Weiterverarbeitung in Ihrem Betrieb relevant sind.*

- 1 Stadt und LK Passau ○
- 2 LK Regen ○
- 3 LK Deggendorf ○
- 4 LK Freyung-Grafenau ○
- 5 LK Kelheim ○
- 6 Stadt Straubing/ LK Straubing-Bogen ○
- 7 LK Rottal-Inn ○
- 8 LK Dingolfing-Landau ○
- 9 Stadt und LK Landshut ○
- 10 Stadt und LK Regensburg ○
- 11 Stadt und LK München ○
- 12 Städte Nürnberg/ Fürth/ Erlangen ○
- 13 Oberpfalz ○
- 14 Oberbayern ○
- 15 übriges Bayern ○
- 16 übriges Deutschland (ohne Bayern) ○
- 17 Oberösterreich ○
- 18 Region Salzburg ○
- 19 übriges Österreich ○
- 20 Region Budweis (Südböhmen) ○
- 21 Region Pilsen (Westböhmen) ○
- 22 Region Prag (Mittelböhmen) ○
- 23 übriges Tschechien ○
- 24 übriges Osteuropa (ohne Tschechien) ○
- 25 übriges Westeuropa ○
- 26 übrige Welt ○

11. Welche der genannten Regionen ist der <u>wichtigste Beschaffungsmarkt</u> für Ihren Betrieb?

Nummer der Region (vgl. Frage 10): _____

12. In welcher der folgenden Regionen <u>setzt</u> Ihr Betrieb <u>Waren/Dienstleistungen ab</u>?
Bitte kreuzen Sie alle Regionen an, in denen Ihr Betrieb Waren und Dienstleistungen absetzt.

- 1 Stadt und LK Passau ○
- 2 LK Regen ○
- 3 LK Deggendorf ○
- 4 LK Freyung-Grafenau ○
- 5 LK Kelheim ○
- 6 Stadt Straubing/ LK Straubing-Bogen ○
- 7 LK Rottal-Inn ○
- 8 LK Dingolfing-Landau ○
- 9 Stadt und LK Landshut ○
- 10 Stadt und LK Regensburg ○
- 11 Stadt und LK München ○
- 12 Städte Nürnberg/ Fürth/ Erlangen ○
- 13 Oberpfalz ○
- 14 Oberbayern ○
- 15 übriges Bayern ○
- 16 übriges Deutschland (ohne Bayern) ○
- 17 Oberösterreich ○
- 18 Region Salzburg ○
- 19 übriges Österreich ○
- 20 Region Budweis (Südböhmen) ○
- 21 Region Pilsen (Westböhmen) ○
- 22 Region Prag (Mittelböhmen) ○
- 23 übriges Tschechien ○
- 24 übriges Osteuropa (ohne Tschechien) ○
- 25 übriges Westeuropa ○
- 26 übrige Welt ○

13. Welche der genannten Regionen ist der <u>wichtigste Absatzmarkt</u> für Ihren Betrieb?

Nummer der Region (vgl. Frage 12): _____

«IHKNR» «IHKNR»
«Kennung»

Anmerkungen und Beispiele zu Frage 14

In **Frage 14** bitten wir Sie eine Tabelle zu den **Kooperationen** Ihres Betriebes in verschiedenen Unternehmensbereichen und mit verschiedenen Kooperationspartnern auszufüllen.

☞ *Mit **Kooperationen** sind dabei alle Formen der partnerschaftlichen Zusammenarbeit (z.B. Einkaufs- und Produktionsverbünde, gemeinsame Produktentwicklung) mit externen Partnern (z.B. anderen Unternehmen, Bildungseinrichtungen) gemeint.*
Nicht gemeint sind mit Kooperationen reine Marktbeziehungen, die nicht über ein einfaches Auftraggeber-Auftragnehmer-Verhältnis hinausgehen.

Dazu bitten wir Sie in Frage 14:

- Kreuzen Sie für jeden Bereich und Partner die Regionen an, in denen Ihr Betrieb Kooperationen hat.
- Markieren Sie die wichtigste Region für jeden Bereich und Partner mit einem Kringel.
- Falls Ihr Betrieb in einem Bereich oder mit einem Partner keine Kooperationen hat, machen Sie dies bitte mit einem Kreuz in der ersten Zeile kenntlich.

Ausfüllbeispiel: *Stellen Sie sich vor, Ihr Betrieb ist an einer Einkaufskooperation mit einem Wettbewerber aus München beteiligt und setzt seine Waren zusammen mit tschechischen Vertriebspartnern in Tschechien ab, wobei der wichtigste Vertriebspartner in Pilsen sitzt. Ihr Betrieb ist zudem an einer Weiterbildungskooperation mit einer Hochschule in Passau beteiligt. In diesem Fall müssten Sie die Tabelle wie folgt ausfüllen:*

	Kooperationen in folgenden Unternehmensbereichen:					Kooperationen mit folgenden Partnern:			
	Einkauf	Produktion	Vertrieb	Forschung & Entwicklung	Aus- und Weiterbildung	Zulieferer	Kunden	Wettbewerber	Hochschulen Forschungseinrichtungen
keine Kooperationen vorhanden		x		x		x	x		
Landkreis Passau/Stadt Passau					x				x
Oberpfalz									
Stadt München	x							x	
Region Pilsen (Westböhmen)			(x)						
übriges Tschechien			x						
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.

14. Im Folgenden interessieren uns Ihre <u>Kooperationen</u> (siehe Definition auf Seite 6) zu Partnern in Regionen innerhalb und außerhalb Niederbayerns.
Dazu bitten wir Sie die Tabelle wie folgt auszufüllen:

- **– Kreuzen Sie für jeden Bereich und für jeden Partner die Regionen an, in denen Ihr Betrieb Kooperationen hat.**
- **- Markieren Sie die wichtigste Region für jeden Bereich und Partner mit einem <u>Kringel.</u>**
- **- Falls Ihr Betrieb in einem Bereich oder mit einem Partner keine Kooperationen hat, machen Sie dies durch ein Kreuz in der ersten Zeile kenntlich.**

	Kooperationen in folgenden Unternehmensbereichen:					Kooperationen mit folgenden Partnern:			
	Beschaffung	Produktion	Absatz	Forschung & Entwicklung	Aus- und Weiterbildung	Zulieferer	Kunden	Wettbewerber	Hochschulen, Forschungseinrichtungen
keine Kooperationen vorhanden									
Niederbayern									
LK Straubing-Bogen/ Stadt Straubing									
LK Regen									
LK Deggendorf									
LK Freyung-Grafenau									
LK Passau/ Stadt Passau									
LK Rottal-Inn									
LK Dingolfing-Landau									
LK Landshut/ Stadt Landshut									
LK Kelheim									
Bayern / Deutschland									
Stadt und LK Regensburg									
Stadt und LK München									
Städte Nürnberg, Fürth, Erlangen									
Oberpfalz									
Oberbayern									
übriges Bayern									
übriges Deutschland (ohne Bayern)									
Österreich									
Oberösterreich									
Region Salzburg									
übriges Österreich									
Tschechien									
Region Budweis (Südböhmen)									
Region Pilsen (Westböhmen)									
Region Prag (Mittelböhmen)									
übriges Tschechien									
Europa / Welt									
übriges Westeuropa (ohne Deutschland und Österreich)									
übriges Osteuropa (ohne Tschechien)									
übrige Welt									

15. Wenn Sie in einem Bereich keine Kooperationen haben, was ist der Hauptgrund für die Nichtkooperation?

☞ *Bitte machen Sie in jeder Zeile nur **ein** Kreuz!*

	schlechte Erfahrungen mit Kooperationspartnern	keine geeigneten Kooperationspartner gefunden	keine Kooperationspartner benötigt
Beschaffung	○	○	○
Produktion	○	○	○
Absatz	○	○	○
Aus- und Weiterbildung	○	○	○
Forschung & Entwicklung	○	○	○

C: ART UND INTENSITÄT DER KOOPERATION

☞ *Im nachfolgenden Abschnitt haben wir einige Fragen zu Art und Intensität der Kooperationsbeziehungen Ihres Betriebes.*

C1: KOOPERATIONEN IN DEN BEREICHEN BESCHAFFUNG, PRODUKTION UND ABSATZ

☞ *Im ersten Abschnitt geht es um Ihre Kooperationen in den Bereichen Beschaffung, Produktion und Absatz. (Wenn Sie in diesen Bereichen keine Kooperationen haben, gehen Sie zu Frage 21!)*

16. Nennen Sie für die Kooperation mit Zulieferern (Vordienstleistern) und Produktionspartnern die jeweilige Bedeutung der folgenden Motive.

☞ *Bitte machen Sie in jeder Zeile nur **ein** Kreuz!*

	sehr wichtig	wichtig	weniger wichtig	unwichtig
Kosteneinsparung	○	○	○	○
Qualitätsverbesserung	○	○	○	○
Erhöhung der Flexibilität	○	○	○	○
bessere Kapazitätsauslastung	○	○	○	○
Risikominderung	○	○	○	○
Wissens- und Technologietransfer	○	○	○	○

17. Nennen Sie für die Kooperation mit Vertriebspartnern die Bedeutung der folgenden Motive

☞ *Bitte machen Sie in jeder Zeile nur **ein** Kreuz!*

	sehr wichtig	wichtig	weniger wichtig	unwichtig
Kosteneinsparung	○	○	○	○
Erhöhung der Flexibilität	○	○	○	○
Zugang zum Absatzmarkt	○	○	○	○

«IHKNR» «IHKNR» **«Kennung»**

18. Nennen Sie für jeden der Bereiche Beschaffung, Produktion und Absatz die wichtigste Art und Weise, in der Kooperationen zustande gekommen sind.

☞ *Bitte machen Sie in jeder Zeile nur **ein** Kreuz!*

	aktive Suche (z.B. Messen, Internet)	persönliche Kontakte	Empfehlungen	Kontakt über Kammern
Beschaffung	○	○	○	○
Produktion	○	○	○	○
Absatz	○	○	○	○

19. Nennen Sie für jeden der Bereiche Beschaffung, Produktion und Absatz das wichtigste Kriterium für die Auswahl der Kooperationspartner.

☞ *Bitte machen Sie in jeder Zeile nur **ein** Kreuz!*

	Preis	Qualität	Vertrauen	räumliche Nähe
Beschaffung	○	○	○	○
Produktion	○	○	○	○
Absatz	○	○	○	○

20. Nennen Sie für jeden der Bereiche Beschaffung, Produktion und Absatz auf der nachfolgenden Skala die Art und Intensität der Kooperationsbeziehungen.

☞ *Bitte machen Sie in jeder Zeile nur **ein** Kreuz!*

	einzelfallweise Kooperation			dauerhafte Kooperation
	1	2	3	4
Beschaffung	○	○	○	○
Produktion	○	○	○	○
Absatz	○	○	○	○

C2: KOOPERATIONEN IN DEN BEREICHEN FORSCHUNG- UND ENTWICKLUNG SOWIE AUS- UND WEITERBILDUNG

☞ *Im nächsten Abschnitt haben wir einige Fragen zu Ihren Kooperationen im Bereich Aus- und Weiterbildung sowie im Bereich Forschung- und Entwicklung. (Wenn Sie in beiden Bereichen keine Kooperationen haben, gehen Sie zu Frage 27!)*

21. Mit welchen der folgenden Einrichtungen unterhält Ihr Betrieb Aus- und Weiterbildungskooperationen?

☞ *Mehrfachnennungen sind möglich!*

keine Kooperationen	○
allgemeinbildende Schulen	○
berufsbildende Schulen	○
Hochschulen	○
Aus- und Weiterbildungsverbünde mit anderen Unternehmen	○
Industrie- und Handelskammern, Handwerkskammern	○
andere Aus- und Weiterbildungseinrichtungen (z.B. private, gemeinnützige)	○

22. Mit welchen der folgenden Einrichtungen unterhält Ihr Betrieb Kooperationen im Bereich Personal/Personalgewinnung?

☞ *Mehrfachnennungen sind möglich!*

- keine Kooperationen ○
- allgemeinbildende Schulen ○
- berufsbildende Schulen ○
- Hochschulen ○
- Personaldienstleister/private Arbeitsvermittler ○

23. Mit welchen der folgenden Akteure hat Ihr Betrieb Forschungs- und Entwicklungskooperationen/-kontakte?

☞ *Mehrfachnennungen sind möglich!*

- keine Kooperationen ○
- Unternehmen innerhalb der Unternehmensgruppe ○
- Zulieferer ○
- Wettbewerber/ andere Unternehmen der gleichen Branche ○
- außeruniversitäre Forschungseinrichtungen ○
- Hochschulen und/oder Technologiezentren ○
- Industrie- und Berufsverbände ○

24. Wenn Ihr Betrieb Kooperationen mit Hochschulen und/oder Technologiezentren hat, in welchen Bereichen wird kooperiert?

☞ *Mehrfachnennungen sind möglich!*

- keine Kooperationen ○
- Entwicklung neuer Produkten und Dienstleistungen ○
- Entwicklung neuer Produktionsmethoden für Güter und Dienstleistungen ○
- Entwicklungen neuer Absatz- und Vermarktungsformen ○
- Kooperation im Bereich Personal ○

25. Welche Formen der Forschungs- und Entwicklungskooperationen nutzt Ihr Betrieb?

☞ *Mehrfachnennungen sind möglich!*

- informelle Treffen/ Gespräche ○
- Austausch von Personal ○
- gemeinsame Entwicklung neuer Produkte und/oder Prozesse ○
- Anpassung von extern entwickelten Produkten und/oder Prozessen ○
- Kauf von Lizenzen und Technologien von Kooperationspartnern ○

26. Wie wichtig sind die folgenden Motive für die Nutzung von Forschungs- und Entwicklungskooperationen für Ihren Betrieb?

☞ *Bitte machen Sie in jeder Zeile nur **ein** Kreuz!*

	sehr wichtig	wichtig	weniger wichtig	un-wichtig
Kosteneinsparung	○	○	○	○
Risikominderung	○	○	○	○
Eintritt in neue Technologiefelder	○	○	○	○
Zugang zu spezifischem Wissen	○	○	○	○
schnellere Entwicklung neuer Produkte/Prozesse	○	○	○	○
Erhöhung der finanziellen Möglichkeiten	○	○	○	○
Aufbau langfristiger strategischer Partnerschaften	○	○	○	○

C3: NETZWERKE, CLUSTER UND BRANCHENVERBÄNDE

☞ *Im nächsten Abschnitt interessieren uns Ihre Verflechtungen innerhalb von Netzwerken, Clustern oder Branchenverbänden. Dazu bitten wir Sie, die nachfolgenden Fragen zu beantworten.*

27. Ist Ihr Betrieb Mitglied eines Netzwerkes, Clusters oder Branchenverbands?

- Ja ○ ☞ *weiter mit Frage 28*
- Nein ○ ☞ *weiter mit Frage 31*

28. Bitte nennen Sie die Netzwerke, Cluster und/oder Branchenverbände in denen Ihr Betrieb Mitglied ist.

☞ *Mehrfachnennungen sind möglich!*

wichtigstes/r Netzwerk/Cluster/Verband:

_____

weitere Netzwerke/Cluster/Verbände:

_____

_____

_____

29. Wie beschreiben Sie auf der folgenden Skala die Kooperation in dem für Ihren Betrieb wichtigsten Netzwerk, Cluster oder Branchenverband?

einzelfallweise Kooperation			dauerhafte Kooperation
1	2	3	4
○	○	○	○

30. Nennen Sie die Bedeutung der folgenden Motive für die Mitgliedschaft in Netzwerken, Clustern oder Branchenverbänden für Ihren Betrieb.

☞ *Bitte machen Sie in jeder Zeile nur **ein** Kreuz!*

	sehr wichtig	wichtig	weniger wichtig	un-wichtig
Erfahrungsaustausch und informelle Vernetzung	○	○	○	○
Wissens- und Technologietransfer	○	○	○	○
Gewinnung von Handelspartnern	○	○	○	○
Erweiterung des Absatzmarktes	○	○	○	○
Aufbau von Produktionskooperationen	○	○	○	○
Marketing/Öffentlichkeitsarbeit	○	○	○	○
bedarfsgerechte Personalgewinnung	○	○	○	○
finanzielle Anreize durch Förderung	○	○	○	○

ABSCHNITT D: WEITERFÜHRENDE FRAGEN

☞ *Im letzten Abschnitt des Fragebogens haben wir noch einige weiterführende Fragen zum Kooperations- und Innovationspotential Ihres Betriebes.*

31. Planen Sie in den nächsten 1-2 Jahren Veränderungen in Ihren Kooperationen?

☞ *Mehrfachnennungen sind möglich!*

- Ja, und zwar Aufbau neuer Kooperationen ○
- Ja, und zwar Vertiefung bestehender Kooperationen ○
- Ja, und zwar Einschränkung/ Beendigung bestehender Kooperationen ○
- Nein, es sind keine Veränderungen in den Kooperationen geplant ○

32. Wie relevant sind die folgenden <u>Kooperationshemmnisse</u> für Ihren Betrieb?

☞ *Bitte machen Sie <u>in jeder Zeile</u> nur **<u>ein</u>** Kreuz!*

	sehr relevant	relevant	weniger relevant	irre-levant
räumliche Distanz	○	○	○	○
fehlendes Vertrauen	○	○	○	○
fehlendes Know-how der potentiellen Partner	○	○	○	○
fehlende Cluster- oder Netzwerkinitiativen	○	○	○	○
administrative-rechtliche Hemmnisse	○	○	○	○
sprachlich-kulturelle Hemmnisse	○	○	○	○

33. Werden in Ihrem Betrieb Forschungs- und Entwicklungsaktivitäten durchgeführt? Wenn ja, wie hoch waren die Ausgaben Ihres Betriebes für Forschungs- und Entwicklungs-aktivitäten (FuE) in Prozent des Umsatzes im Jahr 2011?

- Nein ○
- Ja, und zwar bis zu 2,5% des Umsatzes ○
- Ja, und zwar bis zu 7% des Umsatzes ○
- Ja, mehr als 7% des Umsatzes ○

34. Welche der folgenden Innovationen hat Ihr Betrieb in den letzten drei Jahren eingeführt?

☞ *Innovationen sind Neuerungen, die in Ihrem Betrieb eingeführt worden sind. Es muss sich dabei nicht um Marktneuheiten handeln.*

☞ *Mehrfachnennungen sind möglich!*

- Neue oder signifikant verbesserte Produkte und Dienstleistungen ○
- Neue oder signifikant verbesserte Produktionsmethoden für Güter und Dienstleistungen ○
- Neue Formen der Organisation interner Prozesse (Wissensmanagement,supply chain management, Qualitätsmanagement, etc.) ○
- Neue Formen der Arbeitsorganisation (neue Aus- und Weiterbildungssysteme, Teamwork, etc.) ○
- Neue Formen der externen Beziehungen (neue Kooperationen und Partnerschaften, Outsourcing, etc.) ○
- Neue Formen des Absatzes und der Vermarktung (neue Designs/Verpackungen, Werbemaßnahmen, Vertriebskanäle) ○
- keine Innovationen ○

«IHKNR» «IHKNR» **«Kennung»**

☞ ***Vielen Dank für Ihre Mitarbeit am Fragebogen. Falls Sie Anmerkungen, Hinweise oder Anregungen zu einzelnen Fragen oder zum Fragebogen insgesamt haben, teilen Sie uns diese bitte mit.***

Anmerkungen zum Fragebogen:

_____

_____

_____

_____

_____

Kontaktdaten des Ansprechpartners für Rückfragen in Ihrem Betrieb:

Name: _____

Email: _____

Telefon: _____

II.2 Representativity Tests

Table II.1: Representativity by Size: IHK Firms[a]

	IHK Strukturdaten	**Firm Survey by NIW**
$<$ 1 employee	86.2%	4.1%
1 - 9 employees	9.3%	41.4%
10 to 49 employees	3.5%	33.1%
50 to 99 employees	0.5%	8.9%
100 to 249 employees	0.3%	6.3%
250 to 999 employees	0.2%	4.7%
$>$ 1000 employees	0.01%	1.5%

[a] Values are based on the IHK/HWK Strukturdaten (2012). Table entries show that micro-firms with no employees are largely underrepresented in the sample. This results from the fact that firms with an annual turnover $< 17,500$ Euro are excluded from the analysis. When excluding this category, the sample is, however, representative for the entire population of Lower Bavarian firms.

Table II.2: Representativity by County: IHK Firms[a]

	IHK Strukturdaten	**Firm Survey by NIW**
Passau	24.5%	22.3%
Regen	6.1%	9.3%
Deggendorf	10.8%	13.4%
Freyung-Grafenau	5.8%	8.4%
Landshut	20.0%	15.7%
Straubing and Straubing-Bogen	13.0%	13.9%
Rottal-Inn	12.4%	10.5%
Dingolfing-Landau	7.5%	6.4%

[a] Values are based on the IHK/HWK Strukturdaten (2012). Table entries show that firms from Regen and Deggendorf are slightly overrepresented, whereas firms from Straubing are slightly underrepresented in the firm sample. The χ^2-test, however, indicates that no significant correlation between firms' location and their consideration in the sample exists ($\chi^2 = 5.12$ with 7 DF).

Table II.3: Representativity by County: HWK Firms[a]

	HWK Strukturdaten	**Firm Survey by NIW**
Passau	21.7%	20.2%
Regen	7.8%	9.5%
Deggendorf	10.9%	9.9%
Freyung-Grafenau	7.6%	7.2%
Landshut	19.6%	16.0%
Straubing and Straubing-Bogen	12.8%	15.2%
Rottal-Inn	12.1%	13.7%
Dingolfing-Landau	7.6%	8.4%

[a] Values are based on the IHK/ HWK Strukturdaten (2012). Table entries show that firms from Regen and Straubing are slightly overrepresented, whereas firms from Landshut are slightly underrepresented in the firm sample. The χ^2-test, however, indicates that no significant correlation between firms' location and their consideration in the sample exists ($\chi^2 = 1.99$ with 7 DF).

Item Response Test

Table II.4: Item-Response Analysis: Cooperation and Innovation Variables[a]

	Missing Innovation Variable	Missing Cooperation Variable
Firm Size	.001	.001
	(.300)	(1.10)
Firm sector	.177	-.068
	(1.15)	(-.580)
Innovation	-.462	
	(-1.36)	
Scope Cooperation		-.079
		(-1.12)
Constant	-2.53***	-1.41***
	(-5.55)	(-4.29)
Observations	453	488
McFadden's R^2	.011	.012

[a] Table entries denote regression coefficients of a logistic regression model with a binary variable for missing values on the cooperation variable and missing values on the innovation variable as the dependent variable. T statistics in parentheses. Stars denote significance of the estimates as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

II.3 Results for an Extended Choice Set

Table II.5: Impact of Firm-Specific Factors on Firms' Spatial Cooperation Decisions: Extended Choice Set[a]

	County/ Germany/	Lower Bavaria/ Germany/	Bavaria Germany/	Austria Germany/	Czech Rep. Germany/	World/ Germany/
Specification I						
Constant	2.87***	1.50*	1.40	.067***	.100***	.433**
	(.609)	(.354)	(.335)	(.048)	(.061)	(.144)
Observations	1547					
McFadden's R^2	.001					
Specification II						
Firm Size	.998***	.999**	.999***	1.00**	.999	1.00
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
Sector						
Manufac. Sector	.263***	.359**	.259***	3.71e+09	3.41e+07	4.51e+07
	(.075)	(.107)	(.077)	(1.07e+13)	(1.04e+11)	(6.98e+10)
Service Sector	.128***	.097***	.188***	34.89	.207	.287
	(.041)	(.037)	(.064)	(202452.80)	(1075.83)	(770.61)
Constant	11.922***	4.580***	5.486***	2.08e-11	5.60e-09	1.46e-08
	(3.14)	(1.28)	(1.51)	(5.99e-08)	(.001)	(.001)
Observations	1337					
McFadden's R^2	.060					
Specification III						
Firm Size	.999	.999	.999	1.00	1.00	1.00
	(.001)	(.001)	(.001)	(.002)	(.001)	(.001)
Sector						
Manufac. Sector	.547	.631	.572	4.95e+09***	3.36e+07***	1.75e+08***
	(.424)	(.518)	(.514)	(2.88e+10)	(3.73e+07)	(7.33e+08)
Service Sector	.486	.175	.621	116.01	.425	2.54
	(.440)	(.199)	(.658)	(694.69)	(.455)	(11.21)
R&D Activites	.183**	.330	.461	.198	.553	.725
	(.117)	(.227)	(.344)	(.282)	(.734)	(.742)
Constant	14.89***	5.64**	3.76*	4.85e-11***	1.00e-08***	3.57e-09***
	(9.74)	(3.96)	(2.76)	(3.26e-10)	(1.42e-08)	(1.59e-08)
Observations	1155					
McFadden's R^2	.081					

[a] Table entries denote relative risk ratios of a multinomial logit model. Reference category: Germany. Reference category sector variable: construction sector. Firm clustered standard errors in parentheses. Stars denote significance of the estimates as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

II.4 Results for Various Reference Categories

Reference: Same County

Table II.6: Impact of Firm-Specific Factors on Firms' Spatial Cooperation Decisions: Reference Same County[a]

	Lower Bavaria/ County/	Bavaria/ County/	Germany County/	Abroad County/
Specification I				
Constant	.523***	.488***	.349***	.209***
	(.096)	(.092)	(.074)	(.054)
Observations	1105			
McFadden's R^2	.001			
Specification II				
Firm Size	1.0**	1.00**	1.00***	1.00***
	(.001)	(.001)	(.001)	(.001)
Sector				
Manufac. Sector	1.36	.987	3.80***	4.77e+07
	(.283)	(.200)	(1.28)	(3.09e+10)
Service Sector	.756	1.47	7.81***	3.28
	(.256)	(.399)	(2.97)	(3779.74)
Constant	.384***	.460***	.084***	6.13e-09
	(.064)	(.073)	(.026)	(3.96e-06)
Observations	955			
McFadden's R^2	.061			
Specification III				
Firm Size	1.00	1.00	1.00	1.00
	(.001)	(.001)	(.001)	(.001)
Sector				
Manufac. Sector	1.15	1.05	1.83	1.41e+08***
	(.553)	(.602)	(1.42)	(4.67e+08)
Service Sector	.361	1.28	2.06	8.12
	(.335)	(1.05)	(1.86)	(27.92)
R&D Activites	1.80	2.52	5.46	2.95
	(.855)	(1.42)	(3.46)	(2.11)
Constant	.379**	.253**	.067***	1.06e-09***
	(.149)	(.107)	(.044)	(3.68e-09)
Observations	825			
McFadden's R^2	.083			

[a] Table entries denote relative risk ratios of a multinomial logit model. Reference category: same county. Reference category sector variable: construction sector. Firm clustered standard errors in parentheses. Stars denote significance of the estimates as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Reference: Lower Bavaria

Table II.7: Impact of Firm-Specific Factors on Firms' Spatial Cooperation Decisions: Reference Lower Bavaria[a]

	County/ Lower Bavaria/	Bavaria/ Lower Bavaria/	Germany Lower Bavaria/	Abroad Lower Bavaria/
Specification I				
Constant	1.91***	.033	.667*	.400**
	(.352)	(.200)	(.157)	(.112)
Observations	1105			
McFadden's R^2	.001			
Specification II				
Firm Size	.999**	1.00	1.00***	1.00**
	(.001)	(.001)	(.001)	(.001)
Sector				
Manufac. Sector	.733	.724	2.78***	3.50e+07
	(.152)	(.171)	(.988)	(2.26e+10)
Service Sector	1.32	1.95*	10.33***	4.33
	(.448)	(.707)	(4.66)	(5000.62)
Constant	2.60***	1.20	.218***	1.60e-08
	(.439)	(.231)	(.072)	(.001)
Observations	955			
McFadden's R^2	.061			
Specification III				
Firm Size	1.00	1.00	1.00	1.00*
	(.001)	(.001)	(.001)	(.001)
Sector				
Manufac. Sector	.867	.907	1.59	1.23e+08***
	(.416)	(.589)	(1.30)	(4.04e+08)
Service Sector	2.77	3.54	5.71	22.53
	(2.57)	(3.80)	(6.48)	(78.30)
R&D Activites	.556	1.40	3.03	1.64
	(.264)	(.852)	(2.09)	(1.19)
Constant	2.64**	.667	.177***	2.80e-09***
	(1.04)	(.333)	(.125)	(9.75e-09)
Observations	825			
McFadden's R^2	.083			

[a] Table entries denote relative risk ratios of a multinomial logit model. Reference category: Lower Bavaria. Reference category sector variable: construction sector. Firm clustered standard errors in parentheses. Stars denote significance of the estimates as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Reference: Bavaria

Table II.8: Impact of Firm-Specific Factors on Firms' Spatial Cooperation Decisions: Reference Bavaria[a]

	County/ Bavaria/	Lower Bavaria/ Bavaria/	Germany Bavaria/	Abroad Bavaria/
Specification I				
Constant	2.05***	1.07	.714	.429***
	(.386)	(.230)	(.171)	(.121)
Observations	1105			
McFadden's R^2	.001			
Specification II				
Firm Size	.999**	1.00	1.00***	1.00***
	(.001)	(.001)	(.001)	(.001)
Sector				
Manufac. Sector	1.01	1.38	3.85***	4.84e+07
	(.205)	(.326)	(1.35)	(3.13e+10)
Service Sector	.680	.514*	5.31***	2.23
	(.184)	(.187)	(2.13)	(2569.25)
Constant	2.17***	.835	.182***	1.33e-08
	(.344)	(.161)	(.059)	(8.61e-06)
Observations	955			
McFadden's R^2	.061			
Specification III				
Firm Size	1.00	1.00	1.00	1.00*
	(.001)	(.001)	(.001)	(.001)
Sector				
Manufac. Sector	.957	1.10	1.75	1.35e+08***
	(.551)	(.717)	(1.57)	(4.49e+08)
Service Sector	.783	.282	1.61	6.36
	(.642)	(.303)	(1.71)	(21.97)
R&D Activites	.398	.716	2.17	1.18
	(.224)	(.438)	(1.62)	(.927)
Constant	3.96***	1.50	.265*	4.19e-09***
	(1.68)	(.749)	(.195)	(1.46e-08)
Observations	825			
McFadden's R^2	.083			

[a] Table entries denote relative risk ratios of a multinomial logit model. Reference Category: Bavaria. Reference category sector variable: construction sector. Firm clustered standard errors in parentheses. Stars denote significance of the estimates as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Reference: Europe/World

Table II.9: Impact of Firm-Specific Factors on Firms' Spatial Cooperation Decisions: Reference Europe/World[a]

	County/ Abroad/	Lower Bavaria/ Abroad/	Bavaria Abroad/	Germany Abroad/
Specification I				
Constant	4.78***	2.50***	2.33***	1.67*
	(1.24)	(.699)	(.659)	(.498)
Observations	1105			
McFadden's R^2	.001			
Specification II				
Firm Size	.997***	.998***	1.00***	1.00
	(.001)	(.001)	(.001)	(.001)
Sector				
Manufac. Sector	2.09e-08	2.86e-08	2.07e-08***	7.96e-08
	(.001)	(.001)	(.001)	(.001)
Service Sector	.305	.231	.449	2.38
	(352.31)	(266.29)	(518.30)	(2750.68)
Constant	1.63e+08***	6.26e+07	7.50e+07***	1.37e+07
	(1.05e+11)	(4.05e+10)	(4.85e+10)	(8.84e+09)
Observations	955			
McFadden's R^2	.061			
Specification III				
Firm Size	.998*	.998*	.998*	1.00
	(.001)	(.001)	(.001)	(.001)
Sector				
Manufac. Sector	7.08e-09***	8.16e-09***	7.40e-09***	1.29e-08***
	(2.34e-08)	(2.69e-08)	(2.46e-08)	(4.23e-08)
Service Sector	.123	.044	.157	.253
	(.424)	(.154)	(.543)	(.871)
R&D Activites	.339	.609	.850	1.85
	(.242)	(.443)	(.671)	(1.58)
Constant	9.45e+08***	3.58e+08***	2.39e+08***	6.33e+07***
	(3.29e+09)	(1.25e+09)	(8.34e+08)	(2.21e+08)
Observations	825			
McFadden's R^2	.083			

[a] Table entries denote relative risk ratios of a multinomial logit model. Reference category: Europe/World. Reference category sector variable: construction sector. Firm clustered standard errors in parentheses. Stars denote significance of the estimates as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

II.5 Subsample Analyses for Manufacturing Firms

Any Innovation

Table II.10: Impact of Various Cooperation Patterns on Innovation of Manufacturing Firms: National Partners[a]

	Lower Bavaria			Bavaria			Munich			Germany		
	all	RD	Appl	all	RD	Appl	all	RD	Appl	all	RD	Appl
Cooperation	.037	.131	.029	.052	.087	064	.034	0	.018	.041	0	.026
	(.670)	(1.22)	(.530)	(.910)	(.650)	(1.13)	(.620)	(.)	(.240)	(.600)	(.)	(.380)
Firm Size	√	√	√	√	√	√	√	√	√	√	√	√
R&D Contribution	√	√	√	√	√	√	√	√	√	√	√	√
Observations	399	399	399	399	399	399	399	399	399	399	399	399
McFadden's R^2	.21	.21	.21	.22	.21	.23	.22	.21	.22	.21	.21	.21

[a] Table entries denote average marginal effects of various cooperation patterns (columns) on innovation. Dependent variables: Innovation (any type of innovation). Reference category for sectoral variables: construction sector. T statistics in parentheses. Stars denote significance of the estimates as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table II.11: Impact of Various Cooperation Patterns on Innovation of Manufacturing Firms: International Partners[a]

	Austria			Czech Republic			Distant Regions		
	all	RD	Appl	all	RD	Appl	all	RD	Appl
Cooperation	.216**	0	.216**	-.028	0	-.028	.189	-.461*	.188
	(2.92)	(.)	(2.92)	(-.240)	(.)	(-.240)	(1.50)	(-1.98)	(1.49)
Firm Size	√	√	√	√	√	√	√	√	√
R&D Contribution	√	√	√	√	√	√	√	√	√
Observations	399	399	399	399	399	399	399	399	399
McFadden's R^2	.21	.21	.21	.22	.21	.23	.22	.21	.22

[a] Table entries denote average marginal effects of various cooperation patterns (columns) on innovation. Dependent variables: Innovation (any type of innovation). Reference category for sectoral variables: construction sector. T statistics in parentheses. Stars denote significance of the estimates as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Product Innovation

Table II.12: Impact of Various Cooperation Patterns on Product Innovation of Manufacturing Firms: National Partners[a]

	Lower Bavaria			Bavaria			Munich			Germany		
	all	RD	Appl	all	RD	Appl	all	RD	Appl	all	RD	Appl
Cooperation	-.061	.011	-.074	.048	.088	.076	-.041	0	-.024	.133*	.014	.123*
	(-1.06)	(.140)	(-1.31)	(.820)	(.860)	(1.27)	(-.710)	(.)	(-.710)	(2.17)	(.130)	(1.96)
Firm Size	√	√	√	√	√	√	√	√	√	√	√	√
R&D Contribution	√	√	√	√	√	√	√	√	√	√	√	√
Observations	217	217	217	217	217	217	217	217	217	217	217	217
McFadden's R^2	.21	.21	.21	.22	.21	.23	.22	.21	.22	.21	.21	.21

[a] Table entries denote average marginal effects of various cooperation patterns (columns) on innovation. Dependent variables: product innovation. Reference category for sectoral variables: construction sector. T statistics in parentheses. Stars denote significance of the estimates as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table II.13: Impact of Various Cooperation Patterns on Product Innovation of Manufacturing Firms: International Partners[a]

	Austria			Czech Republic			Distant Regions		
	all	RD	Appl	all	RD	Appl	all	RD	Appl
Cooperation	.114	0	.114	.063	0	.063	.168*	.029	.163*
	(1.62)	(.)	(1.62)	(.610)	(.)	(.610)	(2.07)	(.140)	(1.99)
Firm Size	√	√	√	√	√	√	√	√	√
R&D Contribution	√	√	√	√	√	√	√	√	√
Observations	217	217	217	217	217	217	217	217	217
McFadden's R^2	.21	.21	.21	.22	.21	.23	.22	.21	.22

[a] Table entries denote average marginal effects of various cooperation patterns (columns) on innovation. Dependent variables: product innovation. Reference category for sectoral variables: construction sector. T statistics in parentheses. Stars denote significance of the estimates as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Process Innovation

Table II.14: Impact of Various Cooperation Patterns on Process Innovation of Manufacturing Firms: National Partners[a]

	Lower Bavaria			Bavaria			Munich			Germany		
	all	RD	Appl	all	RD	Appl	all	RD	Appl	all	RD	Appl
Cooperation	.015	.059	-.021	-.052	.034	-.072	-.001	0	-.103	-.058	-.084	-.041
	(.280)	(.970)	(-.400)	(-.940)	(.450)	(-1.25)	(-.020)	(.)	(-1.35)	(-.990)	(-1.03)	(-.700)
Firm Size	√	√	√	√	√	√	√	√	√	√	√	√
R&D Contribution	√	√	√	√	√	√	√	√	√	√	√	√
Observations	217	217	217	217	217	217	217	217	217	217	217	217
McFadden's R^2	.21	.21	.21	.22	.21	.23	.22	.21	.22	.21	.21	.21

[a] Table entries denote average marginal effects of various cooperation patterns (columns) on innovation. Dependent variables: process innovation. Reference category for sectoral variables: construction sector. T statistics in parentheses. Stars denote significance of the estimates as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table II.15: Impact of Various Cooperation Patterns on Process Innovation of Manufacturing Firms: International Partners[a]

	Austria			Czech Republic			Distant Regions		
	all	RD	Appl	all	RD	Appl	all	RD	Appl
Cooperation	-.050	.164	-.050	-.105	0	-.105	-.236***	-.107	-.222***
	(-.730)	(.920)	(-.730)	(-1.18)	(.)	(-1.18)	(-3.61)	(-.760)	(-3.35)
Firm Size	√	√	√	√	√	√	√	√	√
R&D Contribution	√	√	√	√	√	√	√	√	√
Observations	217	217	217	217	217	217	217	217	217
McFadden's R^2	.21	.21	.21	.22	.21	.23	.22	.21	.22

[a] Table entries denote average marginal effects of various cooperation patterns (columns) on innovation. Dependent variables: process innovation. Reference category for sectoral variables: construction sector. T statistics in parentheses. Stars denote significance of the estimates as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Non-Technology Innovation

Table II.16: Impact of Various Cooperation Patterns on Non-Technology Innovation of Manufacturing Firms: National Partners[a]

	Lower Bavaria			Bavaria			Munich			Germany		
	all	RD	Appl	all	RD	Appl	all	RD	Appl	all	RD	Appl
Cooperation	.025	-.045	.059	.099	.046	.138*	.012	0	.032	.039	.033	.088
	(.370)	(-.490)	(.900)	(1.48)	(.400)	(2.05)	(.180)	(.)	(.360)	(.510)	(.270)	(1.18)
Firm Size	√	√	√	√	√	√	√	√	√	√	√	√
R&D Contribution	√	√	√	√	√	√	√	√	√	√	√	√
Observations	217	217	217	217	217	217	217	217	217	217	217	217
McFadden's R^2	.21	.21	.21	.22	.21	.23	.22	.21	.22	.21	.21	.21

[a] Table entries denote average marginal effects of various cooperation patterns (columns) on innovation. Dependent variables: non-technology innovation. Reference category for sectoral variables: construction sector. T statistics in parentheses. Stars denote significance of the estimates as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table II.17: Impact of Various Cooperation Patterns on Non-Technology Innovation of Manufacturing Firms: International Partners[a]

	Austria			Czech Republic			Distant Regions		
	all	RD	Appl	all	RD	Appl	all	RD	Appl
Cooperation	.090	-.221	.090	.021	0	.021	.107	-.370	.135
	(1.08)	(-.920)	(1.08)	(.170)	(.)	(.170)	(1.15)	(-1.81)	(1.45)
Firm Size	√	√	√	√	√	√	√	√	√
R&D Contribution	√	√	√	√	√	√	√	√	√
Observations	217	217	217	217	217	217	217	217	217
McFadden's R^2	.21	.21	.21	.22	.21	.23	.22	.21	.22

[a] Table entries denote average marginal effects of various cooperation patterns (columns) on innovation. Dependent variables: non-technology innovation. Reference category for sectoral variables: construction sector. T statistics in parentheses. Stars denote significance of the estimates as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Bibliography

Abadie, A., Diamond, A. and Hainmueller, J. (2010). Synthetic Control Methods for Comparative Case Studies: Estimating the Effect of California's Tobacco Control Program. *Journal of the American Statistical Association*, 105(490):493–505.

Abadie, A., Diamond, A. and Hainmueller, J. (2015). Comparative Politics and the Synthetic Control Method. *American Journal of Political Science*, 59(2):495–510.

Abadie, A. and Gardeazabal, J. (2003). The Economic Costs of Conflict: A Case Study of the Basque Country. *American Economic Review*, 93(1):113–132.

Alamá-Sabater, L., Artal-Tur, A. and Navarro-Azorín, J. (2011). Industrial Location, Spatial Discrete Choice Models and the Need to Account for Neighbourhood Effects. *The Annals of Regional Science*, 47(2):393–418.

Allison, P. (2012). *Logistic Regression Using SAS: Theory and Application.* Carry, NC: SAS Institute.

Alonso-Borrego, C., Garoupa, N. and Vázquez, P. (2012). Does Immigration Cause Crime? Evidence from Spain. *American Law and Economics Review*, 14(1):165-191.

Anderson, J. and O'Dowd, L. (1999). Borders, Border Regions and Territoriality: Contradictory Meanings, Changing Significance. *Regional Studies*, 33(7):593–604.

Arranz, N. and Fernandez de Arroyabe, J. (2008). The Choice of Partners in R&D Cooperation: An Empirical Analysis of Spanish Firms. *Technovation*, 28(1-2):88–100.

Asheim, B. (1996). Industrial Districts as Learning Regions: A Condition for Prosperity. *European Planning Studies*, 4(4):379–400.

Asheim, B., Boschma, R. and Cooke, P. (2011). Constructing Regional Advantage: Platform Policies Based on Related Variety and Differentiated Knowledge Bases. *Regional Studies*, 45(7):893–904.

Asheim, B. and Gertler, M. (2005). *The Geography of Innovation: Regional Innovation Systems*. Oxford, UK: Oxford University Press.

Asheim, B. and Isaksen, A. (1997). Location, Agglomeration and Innovation: Towards Regional Innovation Systems in Norway? *European Planning Studies*, 5(3):299–330.

Autant-Bernard, C. (2006). Where Do Firms Choose to Locate Their R&D? A Spatial Conditional Logit Analysis on French Data. *European Planning Studies*, 14(9):1187–1208.

Baas, T. and Brücker, H. (2010). Macroeconomic Impact of Eastern Enlargement on Germany and UK: Evidence from a CGE Model. *Applied Economics Letters*, 17(2):125–128.

Bangel, C. (2014). Die Angst geht auf Streife. *ZEIT online*, 12.05.2014 `http://www.zeit.de/politik/deutschland/2014-05/buergerwehr-in-deutschland`.

Barge-gil, A. (2010). Cooperation-Based Innovators and Peripheral Cooperators: An Empirical Analysis of Their Characteristics and Behaviour. *Technovation*, 30(3):195–206.

Bartz, K. and Fuchs-Schündeln, N. (2012). The Role of Borders, Languages, and Currencies as Obstacles to Labor Market Integration. *European Economic Review*, 65(6):1148–1163.

Bathelt, H., Malmberg, A. and Maskell, P. (2004). Clusters and Knowledge: Local Buzz, Global Pipelines and the Process of Knowledge Creation. *Progress in Human Geography*, 28(1):31–56.

Bayerisches Landesamt für Gesundheit Lebensmittelsicherheit (2016). *Crystal Meth*. `http://www.zpg-bayern.de/crystal-meth.html`.

Becker, G. (1968). Crime and Punishment: An Economic Approach. *Journal of Political Economy*, 76(2):169–217.

Becker, W. and Dietz, J. (2004). R&D Cooperation and Innovation Activities of Firms's Evidence for the German Manufacturing Industry. *Research Policy*, 33(2):209–223.

Bederke, J. (2014). Bürgerwehr gegen kriminelle Grenzgänger. *Märkische Allgemeine*, 11.04.2014. `http://www.maz-online.de/Brandenburg/Buergerwehr-gegen-kriminelle-Grenzgaenger`.

Belderbos, R., Carree, M., Diederen, B., Lokshin, B. and Veugelers, R. (2004). Heterogeneity in R&D Cooperation Strategies. *International Journal of Industrial Organization*, 22(8-9):1237-1263.

Bell, B. and Fasani, F. and Machin, S. (2013). Crime and Immigration: Evidence from Large Immigrant Waves. *Review of Economics and Statistics*, 21(3):1278–1290.

Benneworth, P. and Charles, D. (2005). University Spin-off Policies and Economic Development in Less Successful Regions: Learning from two Decades of Policy Practice. *European Planning Studies*, 13(4):537–557.

Berger, P. and Luckmann, T. (1966). *The Social Construction of Reality.* Garden City, NY: Anchor Books.

Bianchi, M., Buonanno, P. and Pinotti, P. (2012). Do Immigrants Cause Crime? *Journal of the European Economic Association* 10(6):1318–1347.

Billmeier, A. and Nannicini, T. (2013). Assessing Economic Liberalization Episodes: A Synthetic Control Approach. *Review of Economics and Statistics*, 95(3):983–1001.

Blundell, R. and Costa-Dias, M. (2000). Evaluation Methods for Non-experimental Data. *Fiscal Studies*, 21(4):427–468.

Boschma, R. (2005). Proximity and Innovation: A Critical Assessment. *Regional Studies*, 39(1):61–74.

Braakmann, N. and Vogel, A. (2010). The Impact of the 2004 EU Enlargement on the Performance of Service Enterprises in Germany's Eastern Border Region. *Review of World Economics*, 146(1):75–89.

Brakman, S., Garretsen, H., Marrewijk, C. and Oumer, A. (2012). The Border Population Effects of EU Integration. *Journal of Regional Science*, 52(1):40–59.

Breschi, S. and Lissoni, F. (2009). Mobility of Skilled Workers and Co-Invention Networks: An Anatomy of Localized Knowledge Flows. *Journal of Economic Geography*, 9(4):439–468.

Bröcker, J., Korzhenevych, A. and Schürmann, C. (2010). Assessing Spatial Equity and Efficiency Impacts of Transport Infrastructure Projects. *Transportation Research Part B*, 44(7): 795–811.

Brülhart, M. (2011). The Spatial Effects of Trade Openness: A Survey. *Review of World Economics*, 86(1):59–83.

Brülhart, M., Carrère, C. and Trionfetti, F. (2012). How Wages and Employment Adjust to Trade Liberalization: Quasi-experimental Evidence from Austria. *Journal of International Economics*, 86(1):68–81.

Brülhart, M., Crozet, M. and Koenig, P. (2004). Enlargement and the EU Periphery: The Impact of Changing Market Potential. *The World Economy*, 27(6):853–875.

Bug, M., Kroh, M. and Meier, K. (2015). Regional Crime Rates and Fear of Crime: WISIND Findings. *DIW Economic Bulletin*, 5(12):167–176.

Bundesinstitut für Bau-, Stadt- und Raumforschung (2014). Laufende Raumbeobachtung - Raumabgrenzungen. `http://www.bbsr.bund.de/BBSR/DE/Raumbeobachtung/Raumabgrenzungen/Regionstypen2011/regionstypen.html?nn=443270`.

Bundesinstitut für Bau-, Stadt- und Raumforschung (2016). *INKAR-Indikatoren und Karten zur Raum- und Stadtentwicklung*. `http://www.inkar.de/`.

Bundeskriminalamt (2005). *Polizeiliche Kriminalstatistik Bundesrepublik Deutschland 2004*. Wiesbaden: Bundeskriminalamt.

Bundeskriminalamt (2006). *Polizeiliche Kriminalstatistik Bundesrepublik Deutschland 2005*. Wiesbaden: Bundeskriminalamt.

Bundeskriminalamt (2007). *Polizeiliche Kriminalstatistik Bundesrepublik Deutschland 2006*. Wiesbaden: Bundeskriminalamt.

Bundeskriminalamt (2008). *Polizeiliche Kriminalstatistik Bundesrepublik Deutschland 2007*. Wiesbaden: Bundeskriminalamt.

Bundeskriminalamt (2009). *Polizeiliche Kriminalstatistik Bundesrepublik Deutschland 2008*. Wiesbaden: Bundeskriminalamt.

Bundeskriminalamt (2016). Allgemeine Hinweise zur PKS - Bedeutung, Inhalt, Aussagekraft. `http://www.bka.de/nn_224658/DE/Publikationen/PolizeilicheKriminalstatistik/AllgemeineHinweise/allgemeineHinweise__node.html?__nnn=true`.

Bundesministerium des Inneren (2010a). *Der Erweiterte Schengenraum - Eine Bilanz für Deutschland*. Bericht des Bundesministeriums des Inneren (2010) `http:`

//www.bmi.bund.de/SharedDocs/Downloads/DE/Themen/Gesellschaft-Verfassung/EuropaInternationales/schengen_bilanz.html.

Bundesministerium des Inneren (2010b). *Migrationsbericht 2008* . Migrationsbericht des Bundesamtes für Migration und Flüchtlinge im Auftrag der Bundesregierung. https://www.bamf.de/SharedDocs/Anlagen/DE/Publikationen/Migrationsberichte/migrationsbericht-2008.pdf?__blob=publicationFile.

Bundesministerium für Wirtschaft und Energie (2016a). *Gemeinschaftsaufgabe Verbesserung der regionalen Wirtschaftsstruktur (GRW)*. http://www.bmwi.de/DE/Themen/Wirtschaft/Regionalpolitik/gemeinschaftsaufgabe,did=151112.html.

Bundesministerium für Wirtschaft und Energie (2016b). *Förderperiode 2007-2013*. http://www.bmwi.de/DE/Themen/Europa/Strukturfonds/foerderperiode-2007-2013.html.

Camagni, R. and Capello, R. (2013). Regional Innovation Patterns and the EU Regional Policy Reform: Toward Smart Innovation Policies. *Growth and Change*, 44(2):355–389.

Camagni, R., Capello, R. and Lenzi, C. (2014). A Territorial Taxonomy of Innovative Regions and the European Regional Policy Reform: Smart Innovation Policies. *Scienze Regionali*, 37:69–105.

Cambridge Econometrics (2015). European Regional Database. http://www.camecon.com/SubNational/SubNationalEurope/RegionalDatabase.aspx.

Campos, N., Coricelli, F. and Moretti, L. (2014). Economic Growth and Political Integration: Estimating the Benefits from Membership in the European Union Using the Synthetic Counterfactuals Method. *IZA Discussion Paper*, 8162:1–37.

Capello, R. (2007). *Regional Economics*. New York, NY: Routledge.

Caragliu, A. and Nijkamp, P. (2012). The Impact of Regional Absorptive Capacity on Spatial Knowledge Spillovers: The Cohen and Levinthal Model Revisited. *Applied Economics*, 44(11):1363–1374.

Carlton, D. (1983). The Location and Employment Choices of New Firms: An Econometric Model with Discrete and Continuous Endogenous Variables. *The Review of Economics and Statistics*, 65(3):440–449.

Ceccato, V. and Haining, R. (2004). Crime in Border Regions: The Scandinavian Case of Öresund, 1998–2001. *Annals of the Association of American Geographers*, 94(4):807–826.

Cohen, W. and Levinthal, D. (1990). Absorptive Capacity: A New Perspective on Learning and Innovation. *Administrative Science Quarterly*, 35(1):128–152.

Cooke, P. (2001). Regional Innovation Systems, Clusters, and the Knowledge Economy. *Industrial and Corporate Change*, 10(4):945–974.

Copus, A. and Skuras, D. (2006). Business Networks and Innovation in Selected Lagging Areas of the European Union: A Spatial Perspective. *European Planning Studies*, 14(1):79–93.

Crescenzi, R. and Rodríguez-Pose, A. (2008). Research and Development, Spillovers, Innovation Systems, and the Genesis of Regional Growth in Europe. *Regional Studies*, 42(1):51–67.

Crescenzi, R. and Rodríguez-Pose, A. (2012). Infrastructure and Regional Growth in the European Union. *Papers in Regional Science*, 91(3):487–513.

Crozet, M. and Koenig, P. (2004). EU Enlargement and the Internal Geography of Countries. *Journal of Comparative Economics*, 32(2):265–279.

Cuaresma-Crespo, J., Doppelhofer, G. and Feldkircher, M. (2014). The Determinants of Economic Growth in European Regions. *Regional Studies*, 48(1):44–67.

Dauth, W., Findeisen, S. and Suedekum, J. (2014). The Rise of the East and the Far East: German Labor Markets and Trade Integration. *Journal of the European Economic Association*, 12(6):1643–1675.

Davis, D. and Gift, T. (2014). The Positive Effects of the Schengen Agreement on European Trade. *The World Economy*, 37(11):1541–1557.

D'Este, P., Guy, F. and Iammarino, S. (2013). Shaping the Formation of University–Industry Research Collaborations: What Type of Proximity Does Really Matter? *Journal of Economic Geography*, 13(4):537-558.

Dow, J. and Endersby, J. (2004). Multinomial Probit and Multinomial Logit: A Comparison of Choice Models for Voting Research. *Electoral Studies*, 23(1):107–122.

Dünkel, F. and Geng, B. (2013). Die Entwicklung der Gefangenenraten im nationalen und internationalen Vergleich. Indikator für Punitivität? *Soziale Probleme*, 24(1):42–66.

Duranton, G. and Puga, D. (2004). Micro-Foundations of Urban Agglomeration Economies. *Handbook of Regional and Urban Economics*, 4:2063–2117.

Ehrlich, I. (1973). Participation in Illegitimate Activities: A Theoretical and Empirical Investigation. *Journal of Political Economy*, 81(3):521-565.

Elsner, B. (2013a). Does Emigration Benefit the Stayers? Evidence from EU Enlargement. *Journal of Population Economics*, 26(2):531–553.

Elsner, B. (2013b). Emigration and Wages: The EU Enlargement Experiment. *Journal of International Economics*, 91(1):154–163.

Entorf, H. and Spengler, H. (2000). Socioeconomic and Demographic Factors of Crime in Germany. Evidence from Panel Data of German States. *International Review of Law and Economics*, 20(2000):75–106.

Epstein, R. and Jacoby, W. (2014). Eastern Enlargement Ten Years On: Transcending the East–West Divide? *JCMS: Journal of Common Market Studies*, 52(1):1–16.

European Commision (2001). On the Impact of Enlargement on Regions Bordering Candidate Countries. Community Action for Border Regions. `http://ec.europa.eu/regional_policy/sources/docoffic/official/communic/pdf/borden.pdf`.

European Commission (2006). Die neue KMU Definition. `http://ec.europa.eu/enterprise/policies/sme/files/sme_definition/sme_user_guide_de.pdf`.

European Commission (2010). Europe 2020: A Strategy for Smart, Sustainable and Inclusive Growth. COM2010/2020final. `http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:2020:FIN:EN:PDF`.

European Commission (2012). *Biannual Report on the Functioning of the Schengen Area.* Communication from the Commission to the European Parliament and the Council. COM(2012)230.Final. `http://ec.europa.eu/dgs/home-affairs/doc_centre/borders/docs/biannual_report_on_the_functioning_of_the_schengen_area_20111101-20120430.pdf`.

European Commission (2015). Objective 1: Eligible Regions. `http://ec.europa.eu/regional_policy/archive/objective1/regions_en.htm`.

Eurostat Regional Database (2016). `http://http://ec.europa.eu/eurostat/web/regions/data/database`.

Fagerberg, J. (2002). *Technology, Growth and Competitivness: Selected Essays.* Cheltenham, UK: Edward Elgar Publishing.

Fitjar, R. and Rodríguez-Pose, A. (2011). Innovating in the Periphery: Firms, Values and Innovation in Southwest Norway. *European Planning Studies*, 19(4):555–574.

Forster, B. (2007). Anpassungsdruck und Anpassungsstrategien des grenznahen Handwerks angesichts veränderter Wettbewerbsbedingungen im Zuge der EU-Erweiterung 2004. *Wirtschaft und Raum*, Band 15.

Franco, C. and Gussoni, M. (2010). Firms' R&D Cooperation Strategies: The Partner Choice. *Discussion Paper 104, University of Pisa.*

Gathmann, C., Helm, I. and Schönberg, U. (2014). *Spillover Effects in Local Labor Markets: Evidence from Mass Layoffs.* Kiel und Hamburg: ZBW-Deutsche Zentralbibliothek für Wirtschaftswissenschaften, Leibniz-Informationszentrum Wirtschaft.

Gertler, M. (2003). Tacit Knowledge and the Economic Geography of Context, or the Undefinable Tacitness of Being (There). *Journal of Economic Geography*, 3(1):75–99.

Gertler, M. (2004). *Manufacturing Culture: The Institutional Geography of Industrial Practice.* Oxford, UK: Oxford University Press.

Geweke, J., Keane, M. and Runkle, D. (1994). Alternative Computational Approaches to Inference in the Multinomial Probit Model. *The Review of Economics and Statistics*, 76(4):609–632.

Giersch, H. (1950). Economic Union between Nations and the Location of Industries. *The Review of Economic Studies*, 17(2):87–97.

Grillitsch, M. and Nilsson, M. (2015). Innovation in Peripheral Regions: Do Collaborations Compensate for a Lack of Local Knowledge Spillovers? *The Annals of Regional Science*, 54(1):299–321.

Grillitsch, M. and Trippl, M. (2013). Combining Knowledge from Different Sources, Channels and Geographical Scales. *European Planning Studies*, 22(1):2305–2325.

Haeussler, C., Patzelt, H. and Zahra, S. (2012). Strategic Alliances and Product Development in High Technology New Firms: The Moderating Effect of Technological Capabilities. *Journal of Business Venturing*, 27(2):217–233.

Hansen, T. and Winther, L. (2011). Innovation, Regional Development and Relations between High- and Low-Tech Industries. *European Urban and Regional Studies*, 18(3):321–339.

Hansen, T. and Winther, L. (2014). Competitive Low-Tech Manufacturing and Challenges for Regional Policy in the European Context: Lessons from the Danish Experience. *Cambridge Journal of Regions, Economy and Society*, 7(3):449–470.

Head, K. and Mayer, T. (2000). Non-Europe: The Magnitude and Causes of Market Fragmentation in the EU. *Weltwirtschaftliches Archiv*, 136(2):284–314.

Heidenreich, M. (2009). Innovation Patterns and Location of European Low and Medium-Technology Industries. *Research Policy*, 38(3):483–494.

Hipp, C. and Grupp, H. (2005). Innovation in the Service Sector: The Demand for Service-specific Innovation Measurement Concepts and Typologies. *Research Policy*, 34(4):517–535.

Hirsch-Kreinsen, H. (2008). Low-Tech Innovations. *Industry and Innovation*, 15(1):19–43.

Hirsch-Kreinsen, H., Jacobson, D., Laestadius, S. and Smith, K. (2005). Low and Medium Technology Industries in the Knowledge Economy: The Analytical Issues. In: Hirsch-Kreinsen, H., Jacobson, D. and S. Laestadius (Eds.) *Low and Medium Technology Industries in the Knowledge Economy*, 11-30. Frankfurt: Peter Lang.

Hirtenlehner, H. and Hummelsheim, D. (2015). Kriminalitätsfurcht und Sicherheitsempfinden: Die Angst der Bürger vor dem Verbrechen (und dem, was sie dafür halten). In: Guzy, N., Birkel, C. and Mischkowitz, P. (Eds.) *Viktimisierungsbefragung in Deutschland*, 458–488. Bundeskriminalamt 2015.

Holland, P. (1986). Statistics and Causal Inference. *Journal of the American Statistical Association*, 8(396):945–960.

Horowitz, J. (1980). The Accuracy of the Multinomial Logit Model as an Approximation to the Multinomial Probit Model of Travel Demand. *Transportation Research B*, 14(4):331–341.

Huggins, R. and Johnston, A. (2009). Knowledge Networks in an Uncompetitive Region: SME Innovation and Growth. *Growth and Change*, 40(2):227–259.

Iammarino, S. (2005). An Evolutionary Integrated View of Regional Systems of Innovation: Concepts, Measures and Historical Perspectives. *European Planning Studies*, 13(4):497–515.

Industrie- und Handelskammer Niederbayern and Handwerkskammer Niederbayern-Oberpfalz (2012). Standort Niederbayern - Strukturdaten 2012. `http://www.regierung.niederbayern.bayern.de/media/niederbayern/zahlen_statistiken_karten/strukturdaten2012.pdf`.

Jensen, M., Johnson, B., Lorenz, E. and Lundvall, B. (2007). Forms of Knowledge and Modes of Innovation. *Research Policy*, 36(5):680–693.

Johnson, D. (2014). EU Migrant Criminal Activity: Exploring Spatial Diversity and Volume of Criminal Activity Attributed to inter EU Migrants in England. *Applied Geography*, 50:48–62.

Kaiser, U. (2002). An Empirical Test of Models Explaining Research Expenditures and Research Cooperation: Evidence for the German Service Sector. *International Journal of Industrial Organization*, 20(6):747–774.

Killias, M. (1993). Will Open Borders Result in more Crime? *European Journal on Criminal Policy and Research*, 1(3):7-9.

Kirner, E., Kinkel, S. and Jaeger, A. (2009). Innovation Paths and the Innovation Performance of Low-Technology Firms - An Empirical Analysis of German Industry. *Research Policy*, 38(3):447–458.

Knippschild, R. (2011). Cross-border Spatial Planning: Understanding, Designing and Managing Cooperation Processes in the German–Polish–Czech Borderland. *European Planning Studies*, 19(4):629–645.

Kolossov, V. (2005). Border Studies: Changing Perspectives and Theoretical Approaches. *Geopolitics*, 10(4):606–632.

Krätke, S. (2002). The Regional Impact of EU Eastern Enlargement: A View from Germany. *European Planning Studies*, 10(5):651–664.

Krätke, S. and Borst, R. (2007). EU Eastern Enlargement and the Configuration of German-Polish Inter-Firm Linkages. *Tijdschrift voor Economische en Sociale Geografie*, 98(5):621–640.

Krugman, P. (1991). Increasing Returns and Economic Geography. *Journal of Political Economy*, 99(3):483–499.

Kujath, H. (2002). Auswirkungen der transnationalen Verflechtungen deutscher Metropolräume auf die nationale Raumstruktur und Raumpolitik. *Informationen zur Raumentwicklung*, 6(7):325–339.

Lagendijk, A. and Lorentzen, A. (2007). Proximity, Knowledge and Innovation in Peripheral Regions. On the Intersection between Geographical and Organizational Proximity. *European Planning Studies*, 15(4):457–466.

Land Brandenburg (2014). Landtagswahl 2014 - Ergebnistabelle nach Wahlkreisen. https://www.wahlergebnisse.brandenburg.de/wahlen/LT2014/ergebnis/dyndaten/E_LT14_TabWkr01_Tabkern.asp?sel1=1253&sel2=0669.

Leick, B. (2010). What Determines the Co-operative Potential for Firms in Western European and CEE Border Regions? A Comparative Micro-Level Analysis. *Economic and Business Review for Central and South-Eastern Europe*, 12(2):109–128.

Long, J. and Freese, J. (2006). *Regression Models for Categorical Dependent Variables Using Stata.* College Station, TX: Stata Press.

Lösch, A. (1944). *Die räumliche Ordnung der Wirtschaft.* Jena: G. Fischer.

Lundquist, K. and Trippl, M. (2013). Distance, Proximity and Types of Cross-Border Innovation Systems: A Conceptual Analysis. *Regional Studies*, 47(3):450–460.

Malmberg, A. and Maskell P. (1999). The Competitiveness of Firms and Regions: Ubiquitification and the Importance of Localized Learning. *European Urban and Regional Studies*, 6(1):9–25.

Malmberg, A. and Maskell P. (2006). Localized Learning Revisited. *Growth and Change*, 37(1):1–18.

Martin, R. and Moodysson, J. (2013). Comparing Knowledge Bases: On the Geography and Organization of Knowledge Sourcing in the Regional Innovation System of Scania, Sweden. *European Urban and Regional Studies*, 20(1):170–187.

Maskell, P. and Malmberg, A. (2007). Myopia, Knowledge Development and Cluster Evolution. *Journal of Economic Geography*, 7(5):603–618.

McCann, P. and Ortega-Argilés, R. (2015). Smart Specialization, Regional Growth and Applications to European Union Cohesion Policy. *Regional Studies*, 49(8):1291–1302.

McFadden, D. (1974). Conditional Logit Analysis of Qualitative Choice Behavior. In: Zarenbka, P. (Ed.) *Frontiers in Econometrics*, 105-142. New York, NY: Academic Press.

Miotti, L. and Sachwald, F. (2003). Co-operative R&D: Why and with Whom? An Integrated Framework of Analysis. *Research Policy*, 32(8):1481–1499.

Morgan, K. (1997). The Learning Region: Institutions, Innovation and Regional Renewal. *Regional Studies*, 41(1):147–159.

Morrison, A., Rabellotti, R., and Zirulia, L. (2013). When Do Global Pipelines Enhance the Diffusion of Knowledge in Clusters? *Economic Geography*, 89(1):77–96.

Newman, D. (2006). The Lines that Continue to Separate Us: Borders in Our Borderless World. *Progress in Human Geography*, 30(2):143–161.

Niebuhr, A. (2008). The Impact of EU Enlargement on European Border Regions. *International Journal of Public Policy*, 3(3):163–186.

Niebuhr, A. and Stiller, S. (2002). Integration Effects in Border Regions: A Survey of Economic Theory and Empirical Studies. *HWWA Discussion Paper*, 179:1–30.

Nitsch, V. (2000). National Borders and International Trade: Evidence from the European Union. *Canadian Journal of Economics*, 33(4):1091-1105.

O'Dowd, L. (2002). The Changing Significance of European Borders. *Regional & Federal Studies*, 12(4):13–36.

OECD (2011). ISIC Rev. 3 Technology Intensity Definition. `http://www.oecd.org/science/inno/48350231.pdf`.

OECD and Eurostat (2005). Oslo Manual. `http://epp.eurostat.ec.europa.eu/cache/ITY_PUBLIC/OSLO/EN/OSLO-EN.PDF`.

Paasi, A. (1999). Boundaries as Social Practice and Discourse: The Finnish-Russian Border. *Regional Studies*, 33(7):669–680.

Paasi, A. (2001). Europe as a Social Process and Discourse Considerations of Place, Boundaries and Identity. *European Urban and Regional Studies*, 8(1):7–28.

Paasi, A. (2011). A Border Theory: An Unattainable Dream or a Realistic Aim for Border Scholars? In: Wastl-Walter, D. (Ed.) *The Ashgate Research Companion to Border Studies*, 11–31. London, UK: Ashgate Publishing, Ltd.

Perkmann, M. (2003). Cross-border Regions in Europe: Significance and Drivers of Regional Cross-border Co-operation. *European Urban and Regional Studies*, 10(2):153–171.

Petrakos, G. and Topaloglou, L. (2008). Economic Geography and European Integration: The Effects on the EU's External Border Regions. *International Journal of Public Policy*, 3(3-4):146–162.

Pippel, G. (2014). R&D Cooperation for Non-Technological Innovations. *Economics of Innovation and New Technology*, 23(7):1–10.

Porter, M. (2000). Location, Competition, and Economic Development: Local Clusters in a Global Economy. *Economic Development Quarterly*, 14(1):15–34.

Quinn, K., Martin, A. and Whitford, A. (1999). Voter Choice in Multi-Party Democracies: A Test of Competing Theories and Models. *American Journal of Political Science*, 43(4):1231–1247.

Rammer, C. and Pesau, A. (2011). Innovationsverhalten der Unternehmen in Deutschland 2011: Aktuelle Entwicklungen - Bundesländerunterschiede - internationaler Vergleich. *Studien zum Deutschen Innovationssystem*, 3-2013.

Rauch, J. (1991). Comparative Advantages, Geographic Advantages and the Volume of Trade. *The Economic Journal*, 101:1230–1244.

Redding, S. and Sturm, D. (2008). The Costs of Remoteness: Evidence from German Division and Reunification. *American Economic Review*, 98(5):1766–1797.

Resmini, L. (2003). Economic Integration, Industry Location and Frontier Economies in Transition Countries. *Economic Systems*, 27(2):205–221.

Rippl, S., Baier, D., Kindervater, A. and Boehnke, K. (2005). Does the Eastern Europe Enlargement of the European Union Mobilize Ethnocentric Attitudes? The Importance of Threats vis-à-vis Situational and Personality Factors. *Zeitschrift für Soziologie*, 34(4):288–310.

Robertson, P. and Patel, P. (2007). New Wine in Old Bottles: Technological Diffusion in Developed Economies. *Research Policy*, 36(5):708–721.

Rodríguez-Pose, A. (2012). Trade and Regional Inequality. *Economic Geography*, 88(2):109–136.

Rosenbaum, P. and Rubin, D. (1983). The Central Role of the Propensity Score in Observational Studies for Causal Effects. *Biometrika*, 70(1):41–55.

Rother, J. (2007). Am Rande des Reichtums. *DIE ZEIT*, 52/2007. `http://www.zeit.de/2007/52/Schengen-Abkommen`.

Rubin, D. (1980). Randomization Analysis of Experimental Data: The Fisher Randomization Test Comment. *Journal of the American Statistical Association*, 75(371):591–593.

Sampson, R., Raudenbush, S. and Earls, F. (1997). Neighborhoods and Violent Crime: A Multilevel Study of Collective Efficacy. *Science*, 277(5328):918–924.

Schiffers, M. (2013). Wirtschaftspolitik. In: M. Glaab and M. Weigl (Eds.) *Politik und Regierung in Bayern*, 289-302. Wiesbaden: Springer.

Schwell, A. (2009). De/securitising the 2007 Schengen Enlargement: Austria and the East. *Journal of Contemporary European Research*, 5(2):243–258.

Schwell, A. (2015). *Europa an der Oder: Die Konstruktion europäischer Sicherheit an der deutsch-polnischen Grenze*. Bielefeld: transcript Verlag.

Scott, J. (2000). Transboundary Cooperation on Germany's Borders: Strategic Regionalism through Multilevel Governance. *Journal of Borderlands Studies*, 15(1):143–167.

Shadish, W., Cook, T. and Campbell, D. (2002). *Experimental and Quasi-Experimental Designs for Generalized Causal Inference*. Belmont, CA: Wadsworth Cengage Learning.

Simon, H. (1979). Rational Decision Making in Business Organizations. *The American Economic Review*, 69(4):493–513.

Smith, J. and Todd, P. (2005). Does Matching Overcome LaLonde's Critique of Nonexperimental Estimators? *Journal of Econometrics*, 125(1):305–353.

Soares, R. (2004). Development, Crime and Punishment: Accounting for the International Differences in Crime Rates. *Journal of Development Economics*, 73(2004):155–184.

Sohn, C. (2014a). Modelling Cross-Border Integration: The Role of Borders as a Resource. *Geopolitics*, 19(3):587–608.

Sohn, C. (2014b). The Border as a Resource in the Global Urban Space: A Contribution to the Cross-Border Metropolis Hypothesis. *International Journal of Urban and Regional Research*, 38(5):1697–1711.

Statistisches Bundesamt (2007). Statistisches Jahrbuch 2007. Wiesbaden: Statistisches Bundesamt.

Statistisches Bundesamt (2009). Statistisches Jahrbuch 2009. Wiesbaden: Statistisches Bundesamt.

Statistisches Bundesamt (2011). Statistisches Jahrbuch 2011. Wiesbaden: Statistisches Bundesamt.

Stuart, E. and Rubin, D. (2008). Best Practices in Quasi-experimental Designs. In: Osborne, J. (Ed.) *Best Practices in Quantitative Methods*, 155-176. Thousand Oaks, CA: Sage Publications, Inc.

Tether, B. (2002). Who Cooperates for Innovation, and Why? An Empirical Analysis. *Research Policy*, 31(6):947–967.

Thissen, M. (2005). RAEM: Regional Applied General Equilibrium Model for the Netherlands. In: van Oort, F., Thissen, M. and van Wissen, L. (Eds.) *A Survey of Spatial-Economic Planning Models in the Netherlands: Theory, Application and Evolution.*, 63–86. Rotterdam/The Hague, NAi Uitgevers.

Tödtling, F., Lehner, P. and Trippl, M. (2006). Innovation in Knowledge Intensive Industries: The Nature and Geography of Knowledge Links. *European Planning Studies*, 14(8):1035–1058.

Tödtling, F., Lengauer, L. and Höglinger, C. (2011). Knowledge Sourcing and Innovation in Thick and Thin Regional Innovation Systems: Comparing ICT Firms in two Austrian Regions. *European Planning Studies*, 19(7):1245–1276.

Topaloglou, L., Kallioras, D., Manetos, P. and Petrakos, G. (2006). A Border Regions Typology in the Enlarged European Union. *Journal of Borderland Studies*, 20(2):67–89.

Train, K. (2009). *Discrete Choice Methods with Simultation.* Cambridge, UK: Cambridge University Press.

Trettin, L. (2010). Einfluss der EU-Osterweiterung auf den Wettbewerb auf Handwerksmärkten. *Springer Wirtschaftsdienst*, 90(1):35–42.

Trippl, M. (2010). Developing Cross-Border Regional Innovation Systems: Key Factors and Challenge. *Tijdschrift voor Economische en Sociale Geografie*, 101(2):150–160.

Vale, M. and Caldeira, J. (2007). Proximity and Knowledge Governance in Localized Production Systems: The Footwear Industry in the North Region of Portugal. *European Planning Studies*, 15(4):531–548.

Van Beers, C. and Zand, F. (2013). R&D Cooperation, Partner Diversity and Innovation Performance: An Empirical Analysis. *Journal of Production Innovation Management*, 31(2):1–21.

Van Houtum, H. (2000). European Perspectives on Borderlands: An Overview of European Geographical Research on Borders and Border Regions. *Journal of Borderlands Studies*, 15(1):56–83.

Varis, M. and Littunen, H. (2012). SMEs and Their Peripheral Innovation Environment: Reflections from a Finnish Case. *European Planning Studies*, 20(4):547–582.

Veugelers, R. (1998). Collaboration in R&D: An Assessment of Theoretical and Empirical Findings. *De Economist*, 146(3):419-443.

Virkkala, S. (2007). Innovation and Networking in Peripheral Areas: A Case Study of Emergence and Change in Rural Manufacturing. *European Planning Studies*, 15(4):511–529.

Wassmann, P., Schiller, D. and Thomsen, S. (2016). Spatial Cooperation Patterns and their Impact on Innovation Outcomes: Lessons from Firms in a Low-Technology Region. *European Planning Studies*, 24(5):833–864.

Wastl-Walter, D. (2011). Introduction. In: Wastl-Walter, D. (Ed.) *The Ashgate Research Companion to Border Studies*, 1–8. London, UK: Ashgate Publishing, Ltd.

Weber, M. (2007). Die Grenzen sind offen - und nun? *Stern* 21.12.2007. `http://www.stern.de/politik/deutschland/schengen-abkommen-die-grenzen-sind-offen---und-nun--3217280.html`.

William, R. (2012). Using the Margins Command to Estimate and Interpret Adjusted Predictions and Marginal Effects. *The Stata Journal*, 12(2):308-331.

Wilson, T. (2009). Forensic Science and the Internationalisation of Policing. In: Fraser, J. and R. Williams (Eds.) *Handbook of Forensic Science*, 491-522. Cullompton: Willian Publishing Ldt.

Xheneti, M., Smallbone, D. and Welter, F. (2013). EU Enlargement Effects on Cross-Border Informal Entrepreneurial Activities. *European Urban and Regional Studies*, 20(3):314–328.

Zentrum für Europäische Wirtschaftsforschung (2014). Results of CIS 2009 for Germany. Center for European Economic Research (ZEW), Mannheim.

Zentrum für Europäische Wirtschaftsforschung (2014). Results of CIS 2012 for Germany. Center for European Economic Research (ZEW), Mannheim.